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PART ONE

Public Forestry on Private Lands

FORESTRY ON PRIVATE LANDS

BY HON. GIFFORD PINCHOT,

United States Forester, and Chairman of the National Conservation
Commission, Washington, D. C.

PUBLIC REGULATION OF PRIVATE FORESTS

BY PROFESSOR HENRY SOLON GRAVES

Director, Forest Schoool, Yale University, New Haven, Conn.

CAN THE STATES REGULATE PRIVATE FORESTS?

BY F. C. ZACHARIE, ESQ.,

Of the Louisiana Bar, New Orleans, La.

FORESTRY ON PRIVATE LANDS

By Hon. Gifford Pinchot,
United States Forester, Chairman National Conservation Commission,
Washington, D. C.

The forest area under public management does not exceed one-fourth of the total forest area of the country. It is not large enough or productive enough to satisfy, even under the most intensive management, more than a fraction of the national demand for wood. We must count, therefore, upon forestry on the lands now privately owned if the United States is to preserve its forest independence and grow the timber which will be needed in the future. The only choice is between a very large addition to the area under public management and management by the owners themselves. What, then, has been the result of private forestry thus far, and what is the prospect of its widespread practice?

What Has Been Done in Private Forestry

Complete information regarding the practice of forestry on private lands is impossible to secure. Since the Forest Service made its offer of coöperation with private forest owners in 1898, examinations of tracts aggregating not far from 10,000,000 acres have been made. This is, of course, but the merest fraction of all the forest in private hands; nor is even this all under forest management. The most important result of this coöperative work is that a large number of private owners have begun at least a partial practice of forestry. However fragmentary, this is of real value, chiefly for its widespread educational effect. In a number of cases working plans were adopted and are being carried out to the satisfaction of the owners. Doubtless many more large undertakings would have been attempted had the facts justified an expectation of larger returns.

Although the conservative management of private forest lands on a considerable scale can scarcely be said to exist as yet, more careful methods are gradually coming into use, while there are half-a-dozen conspicuous examples of thorough and profitable management which indicate what forestry may be expected to accomplish under favorable conditions. There is reason to believe that forestry of some sort is practiced on private lands far more extensively than is generally realized or definitely known.

The heavy loss from fire has led to the largest progress thus far made in this direction. In Oregon, Washington and Idaho large tracts have been placed under organized protection by associations of timber land owners, each member of which pays pro rata toward the cost. The four fire protective associations of northern Idaho expended for fire protection in 1908 $52,284.11 for protecting directly 1,257,787 acres of forest owned by members, and incidentally large areas of adjoining forest. The average cost, including fire fighting, was a little over four cents per acre. The reports of the associations show that the main emphasis was laid upon patrol. Thus one association apportioned its expenditures as follows:

Fire fighting	10.57 per cent.
New trails	16.98 per cent.
Cleaning old trails	12.98 per cent.
Patrol	49.23 per cent.
All other items	10.24 per cent.

In proportion to the completeness of patrol the fire loss is reduced. The forest in any part of the United States can be kept practically free of fire at a cost of from two to four cents per acre spent upon patrol. Next to patrol the chief expense was trail building, which in the above case took 29.96 per cent. of the total protection cost. Provision is made for tool boxes at convenient places, for tools and for horses, as well as for lookout stations.

Equally successful results have not yet been achieved over large areas of private forest lands by either individual or associated efforts in other parts of the country. But numerous small tracts in the East and South are now fairly well protected at moderate cost, and the owners report satisfactory recuperation and reproduction on the protected areas. A case worth mention is that of an owner in the South-central region, a coöperator with the Forest Service, who is applying a working plan in the management of large holdings. Difficulty was found in keeping fires out of the cut-over land, owing to the carelessness of neighboring settlers. Therefore a tract of 1000 acres was set aside and given special protection. Fires have been kept out of this tract for five years, and the owner finds that full reproduction is now the reward of his efforts. Where the business wisdom of protecting a large tract is in doubt such a test may well be tried. It is not costly, and the results speak for themselves. In most cases an object lesson of this sort, driving home the truth about fire protection, will convince the forest owner that he cannot afford fires.

At Corbin Park, in central New Hampshire, some 17,000 acres of forest have been carefully lumbered for five years in accordance with a working plan made by the Forest Service. The park is intended mainly for a game preserve, and all forest work is arranged with respect to its effect upon the game. Nevertheless, the revenue derived from the sale of live game and of forest products more than covers the expense of management and yields a satisfactory profit on the investment, while the future forest crop is steadily coming on. One of the larger private estates on the Hudson offers another example. The property, which embraces 1000 acres, has about 300 acres under forest, from which cordwood from improvement cuttings sells well in the local market. Good roads and the easy accessibility of the tract make it possible to handle the forest in this way as profitably as if large clear fellings were made, so that the maximum financial yield is secured with the minimum of disturbance to forest conditions. Where the stand is sparse planting is done, and the stock is raised in a forest nursery upon the estate. The methods employed and the results secured are of great educational value to the whole community.

A general working plan for a tract of 14,000 acres on North Manitou Island, in Lake Michigan, is being carried out with results which are thus far highly satisfactory to the owners. This plan includes a conspicuously successful system of fire protection, the control of grazing, nursery and forest planting work, improvement cuttings, the present restriction of cutting to overmature timber, the close utilization of lops and tops for cordwood, and the gradual introduction of conifers into the stand.

That good management pays is strikingly shown by the experience of the University of the South, at Sewanee, Tenn. In 1900 the University undertook to manage its 7000 acres of forest in accordance with recommendations made by the Forest Service. Immediate financial returns were desired, while expenditures for improvement were not permitted. In 1899 the University had considered an offer of $3000 for the merchantable timber, and regarded it favorably.

At the time the working plan was made fires were injuring the forest by burning away the humus and damaging the timber. The plan recommended took into consideration the probable rise in local stumpage values, and embraced a series of fellings instead of an immediate sale of the whole merchantable stand. Since the plan went into effect the sum of $18,101.76, above all expenses, has been received from the sale of timber. Meantime, fire has been controlled, excellent reproduction follows and the perpetuation of the forest is assured.

Among those private owners of forest who themselves make use of the timber produced, a number practice forestry in order to insure a permanent supply. Conspicuous among these are wood pulp and paper manufacturers, who largely own the forests from which they get their logs. In many cases they are limiting the cut to what the forest grows each year, thus insuring a permanent sustained yield. They also safeguard the forest by efficient fire protection. Where their present holdings are too small to meet the annual demand, these owners are buying new tracts of forest.

In point of variety and scope the work done on the Biltmore estate, in North Carolina, is remarkable. The forests, which cover 130,000 acres, are made self-sustaining by the production of various forms of material. Four million feet of lumber, five thousand cords of tannic acid wood and fuel, a thousand cords of tanbark, and several hundred cords of pulpwood are cut every year. At the same time the forest itself is steadily increasing in value. Workmen employed along the boundaries of the forest do duty as fire guards. Thus, fire protection is secured at least throughout all the accessible parts of the tract. In connection with all lumbering operations permanent logging roads are built. These minimize the present cost of transportation and will greatly reduce the cost of marketing future crops. The extension of the roads is steadily adding to the investment value of the forest. Moreover, they serve also as a network of fire lines. Forest planting is practiced where fire will not threaten its success. The experimental work in silviculture which is done at Biltmore is certain to make important additions to the science and practice of American forestry.

Since extensive forest planting is to be expected only when the conditions surrounding forestry are far more stable and advantageous than they are at present in most parts of this country, it is not surprising that it has as yet been little attempted by private owners. What forest planting has been done on private lands is mainly the result of artificial encouragement, as by the Federal timber-culture laws, now repealed, or by bounties or tax exemptions offered by the States. The bounty and exemption laws are, as a rule, unsatisfactory in their results, and the forest area of the country has not been much extended by them. The total area of planted forest does not exceed 965,000 acres. Yet the total area of land which would yield its greatest returns from planted forest is more than 50,000,000 acres. In New England forest planting has been particularly successful, and is now being done on an increasing scale. Not including old plantings that have been cut, approximately 25,000 acres have been planted. From the trees that were planted in 1908 about 60,000,000 feet will be available when the plantings grow to merchantable size.

Realizing the advantage of an assured future timber supply, several railroads are adding to their forest holdings and managing their forest properties for the production of a sustained yield of cross-ties for their own roads. The success and economy of preservative treatment now make it possible to use for cross-ties the cheaper and more abundant woods. The practice of forestry by the railroads is, therefore, especially significant, because it includes, in addition to conservative management, the commercial use of timbers of lower grade. In a number of cases planting is done, also with a view to tie production, though such planting is usually a subordinate part of the forest policy.

As widely scattered illustrations of what forestry may do and is already doing these concrete examples are noteworthy. But as progress toward the general practice of forestry by private owners their total amount is altogether insignificant. To judge whether any general movement toward forest management on private holdings may be expected, we must consider what the future situation is likely to be.

What Discourages Private Forestry

Before the future of private forestry can be predicted the obstacles which impede it must be considered.

1. Low stumpage prices hold down forest values and create indifference to them. Forestry means an investment in growing

timber. If the investment is to show a profit the product must not sell below the cost of production. When the logs from the tract of an owner who is practicing forestry go to market their price is fixed by that of the general supply. Cheap stumpage discourages expenditure for protection and management. Ultimately a tree must sell for what it costs to grow it plus the grower's profit. Stumpage prices at this rate would not, it is true, guarantee the practice of forestry, but they would justify the outlay without which forestry is not practicable, and would recommend this expenditure to the owner as good business.

It is worth remarking that a lumber tariff supports stumpage prices. Putting lumber on the free list would enlarge the cheap stumpage area, and so tend to prevent stumpage from selling for enough to cover the cost of producing it. Further, it would not reduce the cost of lumber to the consumer, to whom "cheap lumber" rings persuasively. In my judgment, the entire advantage of a repeal of the lumber tariff would be appropriated by manufacturer and retailer, and the public would profit not at all.

In the end the public, that is to say the consumer, must pay the penalty for the rapid and wasteful harvesting of the present timber supply before a new one can be grown. From the national viewpoint, there is such a thing as having lumber too cheap for our own good. It is as though one were able to buy coal for half the winter below the wholesale price from a coal dealer about to leave town, but for the rest of the winter not able to buy any coal at all. I do not believe that the repeal of the lumber tariff would have any very important results in any direction; but in so far as free lumber would postpone the practice of private forestry, which it would tend to do, it would mean the continued devastation of forests on private lands, and in the end a market rise of timber toward famine prices, while it would lessen the immediate prospect of perpetuating home supplies.

2. The profits of forestry are lower than those offered by most investments in the United States. In older countries the difference, when it exists at all, is far less marked, because of the smaller opportunities for speculative profit. The rather unstable business conditions which prevail in new and relatively undeveloped countries like ours accentuate the preference of capital for enterprises with larger margins of profit.

3. A desire for quick returns rather than long-time investments is another bar to the practice of forestry in the United States. It is especially effective when no returns at all can be expected for some years. This latter obstacle is not always encountered; but when a beginning must be made by forest planting, returns must, of course, wait until the planted forest has acquired market value. Where mature forest forms the initial investment an immediate and usually a sustained yield can be secured.

4. The great danger of destructive forest fires often forces private forest owners to rush their timber to market. In many cases the cost of protection, or an exaggerated estimate of it, appears prohibitive to the owners. It must never be forgotten that without fairly effective protection from fire there is little hope of applying forestry as a permanent system of management. What can actually be done in the way of fire protection, and at what cost, has already been cited in the case of the fire protective associations of the Northwest. Wherever, as notably in the Northwest, coöperation with the state is secured in fire patrol on private tracts, a powerful stimulus is given the practice of private forestry.

5. In the minds of most large stumpage holders the most serious obstacle to conservative lumbering lies in a faulty system of forest taxation. It commonly happens that the working of tax laws discourages the holding either of standing timber or of cut-over lands. The fear of excessive or ill-devised taxation often furnishes the most powerful motive for reckless and premature cutting, and the actual tax burden has caused much cut-over land to revert to the state. It is true that tax assessors have sometimes been lenient in dealing with timberlands, so that in practice the effect of existing laws has not always been without mitigation. Nevertheless, there is no security to the owner of such lands that this state of things will continue. This is a powerful deterrent to the practice of forestry, which requires a long-term investment. In many cases high assessment, especially on non-resident owners, has actually forced the cutting of timber either prematurely or without provision for a second crop. In short, present methods of forest taxation too frequently raise the cost of timber production so high that private forestry becomes artificially and unnaturally precarious, and almost everywhere they menace the owner with a burden greater than the business of growing timber should in fairness be asked to support.

What May Encourage Private Forestry

The days of cheap stumpage in the United States will soon be over. Neither opening the doors to foreign timber, the use of substitutes for wood nor any other device can much delay the advance in forest values here. Foreign supplies are, or soon will be, insufficient to meet the growing home demands. A study of the world's timber supply shows that there will be no continuance of a surplus in the countries which are now exporters of timber. In time most countries, and we very soon, will have to face the alternative of home-grown wood or no wood at all. Therefore, as the forests of the United States, already over-cut, dwindle before axe and saw, there is bound to come so strong a rise in the price of all stumpage as to amount in the end to a timber famine. Just as over-cheap stumpage means wasteful and destructive logging, so stumpage at the cost of production, more than any other single factor, will assist to bring about more conservative management of productive private forest properties. When immature timber is understood to represent a substantial investment it is certain to be considered better worth looking after than is now the case. Protection and management for sustained yield will be given to valuable private forests, just as a permanent supply of raw material receives due attention in the establishment of a costly industrial plant. General business conditions also will tend to become more stable and uniform, and investments which yield a low interest rate and are permanent in character will grow in attractiveness.

The necessities of consumers of wood or of other forest products will promote the practice of forestry by certain classes of interests. Thus, white pine has already been extensively planted by New England box manufacturers; mining companies using large quantities of mine timbers, and pulp and paper manufacturers, already find it worth while to provide for permanent supplies; and railroads, at considerable expense, are planting forests, and planning management of lands already timbered, for the production of cross-ties. In like manner concerns which use or supply water are likely in increasing numbers to own permanently forested catchment basins, which will yield them a supplementary income in wood while regulating stream flow or keeping the water pure. It may well be that private forestry is to have its first development in this field rather than among those who supply timber to the general market.

The Need of Legislation

Legislation may be expected to promote forestry on private lands both by encouragement and by regulation. The fire risk and excessive taxation are the greatest hindrances to forestry. Some excellent state fire laws are in force. The principal present want is efficient fire patrol; the burden of this should be divided between private owners and the state. The greater part of forest taxation can and should be made to fall upon the owner when he is in the best position to carry it—that is, when his forest crop is marketable. This is the practice in countries in which forestry is extensively practiced on private lands. Our state laws should be amended to secure the same result. Every effort should be made to get away from the present practice, which in too many cases exacts a penalty for the production of timber.

The regulation of private forest management by the state must move cautiously, yet the impairment or destruction of the efficiency of forests needed to protect the land or water resources should if necessary, and probably will, be made the subject of restrictive legislation. In a recent decision the Supreme Court of the United States held, in effect, that a state has the right to prevent the impairment of its resources. The application of this principle cannot fail to be extended as the evils which result from damage to protective forests are better realized. Such regulation will not, however, deprive the forest owner of his property, though it will restrict him in the use which he may make of it, just as building laws restrict the owner of city property. If the public interest requires that forests should be maintained without the possibility of beneficial use by the private owner, the state itself should take the property over, of course with due compensation.

In the present status of private forestry and of the law it is difficult to predict how far the courts will go in protecting the interest of the community against the results of wasting and mistreating the forest, but the tendency in that direction is growing in strength with remarkable rapidity. The solution reached in certain European countries may be found applicable to our own conditions. Private owners in these countries may handle their forests as they please provided that they do not mismanage them so as to injure other property. To this end private working plans, or plans of felling, are viséd by the local state forest authorities.

One thing at least seems certain—that the public welfare is so vitally concerned in the conservation of forest resources as to make it unthinkable that the private owner alone can be permitted always to decide whether or not forest conservation shall take effect. In this case it is impossible that a man should be allowed to do altogether as he will with his own. The property rights involved must, of course, be recognized and equitably dealt with. But whether through legislative regulation and restriction, purchase through voluntary sale or condemnation, increasing the attractiveness of forestry, or in the natural course of economic development, the country must be assured of permanent supplies of timber.

Nova Scotia already requires timber land owners to contribute on an acreage basis toward the maintenance of a fire-protective system. Since bad conditions on one man's property are a source of danger to all other forest holdings in the neighborhood, regulations concerning the disposal of slash and similar matters might very logically follow or accompany legislation to establish state patrol of forested regions, and the latter would naturally be paid for, in large part at least, by those who own the property. It is a well-known and widely-applied legal maxim that a man must use his own property in such a way as not to injure another. Is there any reason why forests should be exempt from its application?

But, whatever measures of compulsion it may be necessary to employ against the misuse and destruction of a fundamental and necessary resource, there rests a responsibility on the public as well as on the lumberman. If the owner of timber land owes it as a duty, which is likely sooner or later to be required of him, not to ignore the demands of the common welfare, the commonwealth owes it as a duty, both to all its citizens and to the timber land owners themselves, to promote the practice of private forestry through the removal of all artificial obstacles. It should be the task of legislators and administrators to remove these obstacles, and of public-spirited citizens to organize an enlightened and vigorous public opinion, without which the required laws can neither be enacted nor enforced. Once assured of the protection and encouragement to which they are entitled as custodians of a resource necessary to the common welfare, private forest owners will practice forestry so far as it pays them to do so. Where private incentive proves insufficient to conserve the forests the state will need to intervene.

PUBLIC REGULATION OF PRIVATE FORESTS

By Professor Henry Solon Graves,
Director Forest School, Yale University, New Haven, Conn.

In the past the policy of the Federal Government and of the states has been to dispose of the public lands as rapidly as possible. As a result the bulk of the best forest lands of the country—about three-fourths of the forest area—is in private ownership. These lands represent the most accessible and most productive forests, while those publicly owned are areas which were not valuable enough to attract investors before the policy of restricting their sale was introduced. It is probable that the amount of standing merchantable timber in the public forests is less than one-fifth of the total stumpage of the country. This is true in spite of the fact that there has been but relatively little lumbering in the public forests.

It has been established that the total annual increment of the forests of the country is less than one-third of the amount required by the people for use. The increment of the public forests is increasing; that of private forests is, on the whole, decreasing. While the forest area of the United States, if managed properly, is capable of producing a much larger amount of timber and other forest products than are now annually required for use, there will inevitably be a shortage if the forests continue to be handled as at present.

It is a well-established fact that the destruction of the forests at the headwaters of rivers affects the regularity of their flow. It is the testimony of many manufacturers that the rivers from which they secure power have of late years been much less regular than formerly. This increasing irregularity and the reduction of the minimum flow of the rivers have been very generally attributed to recent heavy lumbering and the destruction of forests by fires in the mountains. While the effect of lumbering on river flow has been popularly exaggerated, it is nevertheless a fact that the conservation of the forests at the sources of streams is of great importance. The mountain forests of the West are so largely owned by the

Government that a permanent forest cover at the headwaters of important western streams is in large measure insured. Nearly all of the mountain forests of the East are privately owned. For the most part these are not being managed at the present time in a conservative manner and there is danger of excessive clearings at the headwaters of our eastern rivers.

The facts explained above make it obvious that the public forests are not sufficient to guarantee a supply of timber and that our future needs will be met only by the practice of forestry on a large portion of what is now private land. It is true also that the water interests in the East require forest conservation in the mountain areas now privately controlled.

There are three possible methods of securing forest conservation of forest lands at present privately owned.

1. State regulation of private forests.
2. State ownership through purchase of large reserves.
3. Practice of forestry by private owners under state co-operation and assistance.

The country has just come to the realization that we are wasting our forest resources and that unless this waste is checked there will be serious consequences. A national movement of this character is necessarily accompanied by a misunderstanding of the exact problem on the part of many persons. It is, therefore, not unnatural that there is a tendency toward legislation designed to regulate private forests, in an endeavor to secure the establishment of forestry as quickly as possible, without a sufficiently careful consideration of the effects which the regulations proposed would be likely to have in actual practice.

The tendency toward the public regulation of the management of private lands has been manifested in bills offered in the legislatures of various states, in reports of state forest officers and in articles on forestry in magazines and other publications. For the most part these propositions have not been based on a thorough knowledge of forest conditions or of scientific forestry. In many instances, they are unsound in principle both from the standpoint of economics and of forestry. Many of the proposals are not capable of practical application and, if they were, would not accomplish the desired results. The efforts toward public regulation of private holdings are significant as showing a commendable realization of the need of forestry. There is danger, however, that these efforts may be misdirected.

The proposals for public regulation of private forestry have one or more of the following purposes:

1. Protection from fire.
2. Regulation of cuttings in order to maintain forest production.
3. The protection and control of soil and water flow.

In former days there existed a spirit that the individual could do what he would with his own forest, even if his neighbor's property was endangered. Recently there has been a growing sense of individual responsibility, particularly in the matter of forest fires. Already many states have laws making the malicious firing of forests a misdemeanor and imposing penalties for the careless use of fire. In some states, burning a fallow and burning brush are forbidden in certain seasons, or a notification must be given to one's neighbor or to a specified town officer before such burning is undertaken. The principle of individual responsibility in starting forest fires is, therefore, well established in a number of states and will doubtless soon be in the laws of all states.

It is recognized by students of forest policy that fire protection cannot be entirely solved by the individual and that laws preventing the starting of fires by design or carelessness will not suffice. Adequate protection can be secured only through organization. There must be a definitely organized service to prevent fires and to extinguish those which may be started from one cause or another. Just as city property is protected through a fire department, so forests must be protected by an organized fire service, adapted to local conditions. The attitude of the private owner is that the state should assist him in the protection of his property which it taxes, that the taxation of forest lands should be based on sound principles, which is not the case at the present time anywhere in the country, and that this taxation should pay for the protection of forests and entitle him to such protection.

From the standpoint of the state it is reasonable to expect that in case a fire service to assist in the protection of private lands is established, the owners should leave their forests in as good condition as is practicable for the prevention of fires and for their extinguishment if started. It is a new principle, which has been proposed in a number of instances, that the state may require private owners to dispose of the slashings after lumbering or in other ways put their forests into good condition for protection.

This principle has been definitely adopted by the advocates of forestry in the lake states. Official representatives of Michigan, Minnesota and Wisconsin recently met in a so-called lake states forestry conference at Madison, Wisconsin, and formulated a definite platform with reference to forest legislation. The portions of the platform, which immediately concern the present discussion, are as follows:

> "WHEREAS, the experience of the fires of the last season has fully demonstrated that the leaving of debris over large areas of land in the form of 'slashes' seriously threatens the safety of all wild lands and forests, as well as farm settlements, and even towns; therefore, be it
>
> "*Resolved,* that all persons cutting and exploiting timber in any part of the lake states here represented should be obliged to dispose of the debris in such manner that it shall not be a menace to the forests; that failure to do this should be punished by a fine commensurate with the extent of the operations and consequent possibility of damage; that the timber cut or standing, as well as the land, should be held to secure the payment of such fines imposed, and that full authority be given to the proper authorities to carry out and interpret the law providing for this disposal of debris or 'slashings.'
>
> "WHEREAS, in the matter of forest fires this conference realizes that these forest fires in the lake states during any dry reason really take on enormous proportions; that we are dealing, therefore, with great calamities affecting human life as well as millions of acres of land and many millions of dollars worth of property; from this it follows that any measures adopted should be adequate to the situation; that efficient preventative and protective measures are the only kind that will really pay, and that such protection in a single year can and will save enough property, such that the interest on the material wealth saved will easily maintain such service or protection; therefore, be it
>
> "*Resolved,* that forest fires, being one of the greatest enemies of the state, and thus akin to riot and invasion, the executive power of the state should be employed to the utmost limit in emergencies in their suppression and control for the protection of the lives and property of the people."

These recommendations have been definitely formulated in a proposed bill now before the Minnesota legislature. The clause of special interest is as follows:

> "SEC. 1787d. Any person or corporation who cuts or fells or causes to be cut or felled timber or wood for commercial purposes shall pile, and under

charge of a competent person or persons burn the slashings (by which is meant the branches, tops and refuse) at the time of cutting; provided, that when the cutting is done between the months of March and November, the slashings shall be piled at the time of cutting and be burned during the following winter."

The same principle is at the basis of a proposal which is to be presented to the New York legislature, requiring private owners to lop the tops after lumbering; that is, to cut off the branches in order to bring them in close contact with the ground, an operation which hastens their decay and thereby lessens the danger from fire.

It has been clearly demonstrated that in the pine forests of the lake states burning of the tops at the time of cutting constitutes the best measure for disposing of them. It has also been shown that unless this material is destroyed, it is practically impossible to guard against serious damage by fire. In the Adirondacks, on the other hand, the character of the forest is such that there are many small trees growing in mixture with the older ones, so that burning of brush would inevitably injure the small timber. Moreover, the forest is damper than a pine forest and it is not so necessary to burn the slash. If the limbs are scattered so as to come in contact with the ground, they absorb moisture so quickly that the measure is adequate to put the forest into condition for protection.

The principle at the basis of these propositions seems to the writer fundamentally sound. The objections which would naturally be brought against the proposals are:

1. That a specific measure like brush burning in a given region might not always be necessary or the best method of fire prevention.
2. That it would be exceedingly difficult to carry out such a law in practice.
3. That it would be an opening wedge for further legislation such as required construction of fire lines.

It is true that brush burning is not always the best method of preparing the forest for fire protection. Even in the pineries it may sometimes be better to lop the tops and scatter the brush. Within a pine region there are necessarily some types of forest in which brush burning would be as injurious to the trees left standing and as unnecessary as in the Adirondack Mountains. Moreover, in a few years with better fire protection than now there will be considerable reproduction coming up throughout the forest and different conditions will prevail. These facts must be taken into consideration in preparing a law for a given region. There must be sufficient elasticity to permit the disposal of the brush in the way which would be best for the forest and practical for the owner.

There would necessarily be many difficulties in requiring private owners to dispose of brush after lumbering if they were not in sympathy with the provision. There would always be a certain number of individuals desirous of securing the privileges of the state fire protection, but who would be unwilling to comply with the provisions of the law. In the writer's judgment, it would be decidedly difficult to carry out and put into effect required disposal of brush unless it is distinctly to the interest of the land owners themselves, unless the methods are both practical and effective, and unless the majority of the owners themselves approve of the law and desire to see it carried out. If these conditions exist in any given region, such a law is applicable and the difficulties in putting it into effect would not be insuperable.

It would take some years to establish a thoroughly practical system of required disposal of brush. During the first few years of its application, there would probably be a good many fires, and some persons would undoubtedly attempt to introduce further regulations, in the belief that fire patrol and burning of brush are not sufficient for effective protection. In fact, certain individuals have already advocated that private individuals be required by law to construct fire lines. Required brush-burning will be successful only to the extent that it is practical. In the same way the construction of fire lines or any other measures will not be used until they are shown to be necessary and practical. In that event it will be entirely possible to bring them into practice.

In several states laws have been suggested which not only place certain restrictions on private owners for protection against fires, but also prescribe how the forests shall be cut. In most cases the proposed laws forbid the cutting of trees below a certain size.

The most comprehensive bill of this character so far presented is that now before the legislature of Maine. This provides for the establishment of all private forests as auxiliary state forests. An owner must secure a license before lumbering his land. It is unlawful to cut any pine or spruce trees less than ten inches in diameter except where necessary in clearing for roads, yards and similar purposes. All trees must be cut by sawing and the stumps may not be over twelve inches high. The tops must be trimmed, and the brush piled and burned. Where such occur, at least three trees of pine and spruce capable of bearing seed must be left on each acre. If an owner wishes to use another system of management, he may do so upon the approval of the state forester. In return he receives protection from fire and exemption from taxes on all growing timber.

In a bill introduced into the Louisiana legislature last year, there is a provision that no private owner has a right to cut down any tree (except fruit or willow trees) less than twelve inches in diameter. It is further made unlawful to cut the trees in such a way as to injure young growth, and tops and brush must be removed from the neighborhood of young trees so as not to injure them. At various times laws have been proposed in New York forbidding private owners to cut their small timber. Usually the limitation of cut to a certain diameter is the method suggested. These proposals are based on the following assumptions:

1. The continuance of forests is necessary for the public welfare because of their indirect protective influences and the maintenance of a supply of wood, timber and other forests products.

2. The destruction of the mountain forests will result in direct injury through disturbance of the flow of the rivers. A reduction of productiveness through destructive management will result in an inadequate supply of timber and other products.

3. The state has a right to prevent a mishandling of its natural resources which would tend to impoverishment of the people.

The Supreme Court of Maine has rendered a decision[1] that the state has a constitutional right to require forest owners to handle their property in such a way as not to injure the public interests. The decision asserts that the state may regulate the lumbering on private lands in order to protect the streams and also in order to maintain the productiveness of the forests in the permanent interests of the owners themselves and of the general public. This decision, if sustained, opens the way for very extensive state regulation of private business, and already it has stimulated the production of a great variety of proposals of the character of the Maine and Louisiana bills already mentioned. In discussing the legal enforcement of the practice of forestry on private lands, it is necessary to keep separate the two purposes: First, to secure a future timber supply, and second, to prevent direct injury through disturbance of river flow and in other ways.

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[1] March 10, 1908.

It has already been explained in the beginning of this paper that the future supply of timber depends in considerable part on the production of forests now in private ownership. The Maine decision is to the effect that the state has a right to compel owners to cut their timber in a certain way in order to contribute to the future yield of forest products. Whether the enforcement by law of certain methods of cutting is the best way to accomplish this result is an entirely different question. In the opinion of the writer such an attempt would be unwise, both from the standpoint of state policy and technical forestry. There is a very close analogy between the maintenance of the production of forest products and of agricultural products. Bad farming is certainly a disadvantage to the community at large. Yet we are not forcing the farmer by law to adopt certain measures of cultivation. It is regarded as a much wiser plan to bring about intelligent agriculture through education and other indirect means. It is far better to show farmers how good agriculture may be to their own advantage and to teach them how to practice it than to force it upon them, even if the first methods require a long time for accomplishment. In the same way forestry for timber production should be brought about through state coöperation and assistance and through education and not by legislation.

Lumbering, not accompanied by fire, usually does not result in devastation. Almost always there are some trees left standing which produce seed and gradually re-establish a forest. Sometimes the lumberman leaves the forest in a fair condition for regrowth. More often the productiveness of the forest is enormously reduced compared with that secured under intelligent practical forestry. Examples of the very destructive lumbering may be found in the South, where the mature pines are cut clear and most of the trees removed from areas of considerable size. It nearly always happens that groups of young trees or individual trees too defective for lumber, but still capable of seed production, are left standing in amounts sufficient to enable a gradual return of the forest. It may take fifty years to re-establish the new crop instead of ten years, and the crop will be a much less valuable one than would result under forestry methods. Thus the average annual increment obtained by ordinary forestry might be 200 board feet and that under destructive lumbering twenty feet. Yet even under the worst methods of cutting some production is secured, provided fires are kept out. If one were to make a large enough investment the growth could be increased much over 200 feet, to a maximum which our studies have not yet determined. It is, therefore, not a question of preventing absolute destruction by the private owner because he does not destroy unless he uses fire. It is a question whether the owner shall maintain his forest production above some specified minimum amount.

The usual method proposed for regulating private forests is to prescribe certain specified rules for cutting to be applied to all types of forest in a given region. Forestry cannot be practiced by rule. A forest is not a uniform crop. It is enormously variable in composition, form, condition and productiveness. The measures necessary to keep up the productiveness must vary with every portion of the forest.

Just what should be done for the maintenance of production depends entirely on the character and condition of each forest, the market conditions, and the special desires of the owners. In many cases a general rule of cutting such as proposed in certain states would not have any better results from the productive standpoint than ordinary lumbering. The Louisiana proposal cited above is a case in point. It advocates the application of a rigid kind of selection system of cutting in yellow pine forests. One of the principal characteristics of the yellow pine forests of Louisiana is that they are composed of stands and groups of trees, each having about the same age. In a mature stand, therefore, the trees below twelve inches are about the same age as those above that limit. Such small trees are usually the poorest in the stand. They have grown very slowly, have been crowded by their neighbors, and their crowns are small and undeveloped. The cutting of a forest under the proposed restriction would leave a considerable number of undersized old trees which would in many cases be blown over and at the best would not grow rapidly after cutting, and would contribute very little to the production of seed. The law restricting the cutting to large trees would, therefore, not secure the results desired.

The bill introduced into the Maine legislature would result in somewhat better silviculture than the Louisiana proposal. In Maine many forests are composed of trees of all ages mingled together. Such a forest is one in which the selection system of cuttings is applicable. A restriction of the diameter is a rough approach to the methods which a forester would use in some stands in Maine but a rigid rule of thumb would inevitably remove many trees which ought to be left, and leave a large number which ought to be removed for the benefit of the forest and which it would pay to cut. Moreover, there are in Maine some types of forest on which a selection cutting is entirely inapplicable and where its use would inevitably be followed by extensive windfall. The methods of silviculture applicable to Maine are in some cases to cut on a selection system and sometimes to cut clear. In a selection system the method of selecting the trees necessarily varies enormously. No rigid rules can be successfully applied.

The application of a law requiring certain measures of silviculture would be exceedingly difficult. An army of inspectors would be needed to enforce the rules. Great antagonism would be aroused against the law among many owners not in sympathy with it, and effective enforcement would often result in the virtual assumption by the state of the management of the property. It is exceedingly unlikely that the results of enforced silviculture would be any better than those which could be secured through indirect state action.

The experience of Europe is interesting in this connection. In the eighteenth century and the early part of the nineteenth century there were many laws in the different states regulating the cutting on private lands. These regulations concerned the rotation of the trees and the methods of cutting them. Some of them were very similar to measures now proposed in this country. It was found that such regulations could not be carried out in practice and in the recent revision of the laws they have been in large part dropped, with the exception of such as refer to the protection forests. Thus in Germany to-day, there are no restrictions whatever on private cutting on over seventy per cent. of the private forests except within the belt of protection forests.

The worst period of forest destruction has been passed. The Government has already a vast domain of national forests on which the best forestry is being introduced as rapidly as possible. The total area of public forests controlled by the Government will soon be not less than 200 million acres. A policy of purchase of state forests has been established in eleven states and there is every prospect that this policy will be adopted in most of the other states in a short time. The purposes of the state forests are:

1. To protect critical watersheds.
2. To produce wood and timber especially of those grades which the private owner will be unlikely to supply.
3. To give a practical demonstration of forestry.

It is reasonable to expect that there will ultimately be state forests aggregating about twenty-five to fifty million acres. Thus there will probably be from two hundred and twenty-five to two hundred and fifty million acres of public forests in the not far distant future, constituting about forty per cent. of the present forest area of the country.

There is every prospect that a policy of state assistance and co-operation with private owners will soon be general. As soon as there is a sane system of taxation of timberlands, and adequate protection from fire, owners will begin to practice forestry more extensively than now. Private forestry will further be stimulated by education through the personal work of the state officers and by practical demonstration of the best methods of forestry in the state reserves. Private forestry will accompany the increase in value of woodlands. As the old timber becomes scarcer the value of growing trees will be better appreciated. Already investors are beginning to buy up second growth woodlands with a view to holding them for their future production. There is no reason why practically all the farm woodlots should not be handled as conservatively as is now the case with many of them in the eastern states where there are state foresters. These woodlots comprise approximately 200 million acres. Public regulation of cutting upon them is certainly unnecessary.

If one subtracts the areas likely to be publicly owned and the woodlots from the total forest area of the country, there remain about 125 to 150 million acres. The writer does not believe that with fire protection, reasonable taxation and state co-operation the owners of these forests will practice such a system of devastation as to warrant the public enforcement of rules of silviculture treatment.

One of the common purposes in proposing the public regulation of private forests is the protection of the sources of rivers. The example of Europe may be cited, where critical areas in the mountains are designated as "Protection Forests." Certain regulations are promulgated for these forests, private as well as public, restricting their use. These regulations which differ in the different countries usually forbid permanent clearings, clear cutting over large areas, and sometimes over small areas, grazing, raking of leaves and any other operation which may result in erosion, landslides, disturbance of stream flow, etc. As a rule, the prescriptions are broad and general and there usually is no attempt to establish cutting rules. As much latitude is given the owner as is compatible with protection. Every assistance is given him by the state forests in applying the best methods of forestry, and often the state takes over entirely the management of certain private holdings within the protective belt.

The principle underlying the restriction of the private forests in a protection belt is that the state may prevent a private individual from so mishandling his property as to injure the property of others. The difficulty in carrying out these regulations is that it is usually impossible to prove that any single cutting does any damage. It is probable that isolated cuttings do not have any measurable influence on water flow. It is only in the case of extensive lumbering over large areas that injury can be shown. It would be necessary, therefore, to determine arbitrarily certain areas where it is believed that extensive deforestation would be detrimental to river flow or cause erosion, and designate these as Protection Forests as in Europe; then to regulate the cuttings upon the private holdings within this area, whether or not it could be shown conclusively that damage would be done by destructive lumbering on any given tract.

Granting that the state has a right to establish protective areas at the headwaters of rivers and to regulate private forests within them, the writer believes that it is a better policy for the state to purchase all those areas which must be kept under permanent forest cover for the public benefit. If there are interstate watersheds where a single state may not be expected to purchase because the protection would primarily be for the benefit of another state the Government should solve the problem by establishing national forests. In this way the burden of preserving the forests for the public benefit is placed upon the public, where it belongs, and not upon a single class of individuals.

In conclusion, it is the opinion of the writer that state regulation of private forests should be confined to restricting the use of fire and to requiring a reasonable organization of the forests for protection, and should not be extended to governing the methods of cutting; that the protection of watersheds should be accomplished by the establishment of public forests; and that the problem of the future timber supply may be solved effectively by means of the public forests supplemented by forestry practiced on private lands under state encouragement and co-operation.

CAN THE STATES REGULATE PRIVATE FORESTS?[1]

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Inasmuch as the major share of the forest lands of the United States is and always will be privately owned, the question of the extent to which the state may regulate the cutting of private forests is one of first importance. The necessity for placing some limitation upon the destruction of timber upon private land is coming to be generally admitted, but there is much difference of opinion as to the extent to which the state may limit the property rights of the owner of forest lands. The purpose of this paper is to consider the legal questions connected with legislation by the states to provide for the public control of private forests.

Last year a bill was introduced into the legislature of Louisiana, the purpose of which was to "preserve and protect timber and lumber resources of the State of Louisiana, and to prohibit the felling, cutting down, girdling, or deadening of trees of a less diameter than twelve inches, measuring four feet from the base, whether upon public or private lands, and to make the same a misdemeanor, and provide for the punishment thereof on conviction." The reasons for the enactment of this measure, as stated in the preamble of the bill, were that "the wholesale and indiscriminate destruction of timber and trees in the State of Louisiana is rapidly tending to produce a dearth of timber and lumber, to the great prejudice and injury of the people of the whole state." Accordingly the bill stipulated that:

> After the passage and promulgation of this act it shall be unlawful for any person or persons to fell or cut down or girdle or deaden any forest tree or trees other than fruit or willow trees, whether upon public or private lands, of a less diameter than twelve inches, measuring four feet from the base, provided always that this shall not apply to timber felled or cut down on privately owned lands for fencing or other domestic purposes, exclusively for the use of the owner of the land or his tenants; nor shall it apply to

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[1] The author requests the editor to state that while the main body of this paper, as is stated in the text, is from a brief prepared by Col. Zacharie, the earlier and later parts of the paper are the work of the editor.

the clearing of lands with the *bona fide* intention of erecting houses or of putting the land so cleared under cultivation, nor the making and cleaning up of ditches, nor for the purpose of creating public or private roads or other works of public utility.

Other provisions of the bill were intended to regulate the manner of cutting trees and to provide penalties for the violation of the act.

The question with which we are here concerned is, does Louisiana or do the other states have the power to pass a law containing provisions similar to those in the measure proposed in Louisiana? To answer this question it is necessary to consider the police powers of the several states. The draft of the bill prepared for the Louisiana legislature was accompanied by an argument as to the economic necessity for the enactment of the measure and as to legal competency of the state under its constitution and the general police powers to enforce the provisions of the proposed law. This brief, written by Harry P. Sneed, Esq., of the Louisiana bar, and the author, contains the following discussion of the police powers of the states as regards the government regulation of the use of private forests:

The police power of Louisiana and the other states has never been positively defined, nor its limits accurately fixed, but all the authorities seem to agree that it extends to the enactment of all reasonable laws and ordinances to protect the interests of the state and its people from injury. Although the generality of law authorities lay down the principle, that the private ownership of land or real estate extends the rights of the owner thereof *de profundis usque ad coelum* (from the depths of earth to the skies), yet they are all agreed that the principle *sic utere tuo ut non laedas alienum* (so use your own as not to injure the property of others), applies to the non-injury of other owners or of the public or the general interests of the state. So ordinances and laws have been sustained prescribing fire limits, building regulations in regard to height, ventilation, plumbing, security against fires, etc., in cities, although they interfered with the complete control or domination of the owner over his private property. [Prentice on Police Powers, p. 19, 448, section 442.] So in regard to fishery laws for the protection of fish, game and song-birds, although the fish may be in unnavigable waters, adjacent to the riparian properties, and the game and song-birds nested on land privately owned. All these laws being considered reasonable laws, controlling the use of private property in the interest of the general public. [Prentice, pp. 29, 42, 58, 59, 177, 347, 456. Freund on Police Power, p. 443, section 419.] So a statute of Indiana, prohibiting the waste of natural gas by burning flambeaux, etc., was sustained. [Freund, p. 448, section 422, and other authorities cited in note, 47 N. E. 40; 49 N. E. 809; 130 Penn St. 235.] In 47 N. E. 20, the Supreme Court of Indiana said that the waste of natural gas by flambeaux, etc., militated against the rights of others and the general public and the statute prohibiting it was within the police power and was constitutional.

So in 49 N. E. 816, under the same statute the Supreme Court of Indiana said: "The object and policy of that inhibition is to prevent, if possible, the exhaustion of the storehouse of nature, wherein is deposited an element that ministers more to the comfort, happiness and well-being of society than any other of the bounties of the earth."

In Georgia *vs.* Tennessee Copper Company, 206 U. S. 230, there was a case presented of a Tennessee copper smelting company, just over the Georgia line, which it was claimed was by its fumes and smoke, etc., injuring property, soil and vegetation in Georgia, and an injunction was sought by the State of Georgia to prevent the injury to such property in the State of Georgia. The Supreme Court of the United States said: "It is a fair and reasonable demand on the part of the sovereign that the air over its territory should not be polluted on a great scale by sulphurous acid gas, that the forests on its mountains, be they better or worse, and whatever domestic destruction they have suffered, they should not be further destroyed or threatened by this act of persons beyond its control, that the crops and orchards on its hills should not be endangered from the same source. If any demand is to be enforced this must be, notwithstanding the hesitation that we might feel if the suit were between private parties, and the doubt whether for the injuries which they might be suffering to their property they should not be left to an action at law."

The brief filed in this case by the counsel for Georgia contains many citations of authorities bearing on this question, that is, that the State of Georgia is *parens patriae,* and as such has the right to control and prevent any injury to its citizens and property holders, even where the injury is inflicted by persons outside its limits. Associate Justice Holmes, the organ of the court, says on page 237: "This is a suit by a state for an injury to it in its capacity of quasi-sovereign. In that capacity the state has an interest independent of and behind the titles of its citizens, in all the earth and air within its domains. It has the last word as to whether its mountains shall be stripped of their forests and its inhabitants shall breathe pure air. It may have to pay individuals before it can utter the word, but with it remains the final power. The alleged damage to the state as a private owner is merely a make-weight, and we may lay on one side the dispute as to whether the destruction of forests has led to the gullying of its roads."

In the well-reasoned opinion in the case of Commonwealth *vs.* Tewsbury, II Metc. 58, we find the following: "Some of these acts, especially those of modern date, and those which prohibit the owner of land from using his herbage either by mowing or grazing, do provide for a compensation to the owner for the damage which he may sustain under the restraints of the act, but many of them do not so provide. It is extremely difficult to lay down any general rule, or draw a precise line between the cases where the restraint of the right of the owner is such that compensation ought to be provided, and where the regulation is such only as to prevent a particular use of the property from being a public nuisance."

In 7 Cushing, pages 85, 86, Chief Justice Shaw, acknowledged one of the ablest jurists, in a long and very able opinion, said: "We think it is a settled principle, growing out of the nature of well-ordered civil society, that every owner of property, however absolute and unqualified may be his title, holds it under the implied liability that his use may be so regulated that it shall not be injurious to the equal enjoyment of others having an equal right to the enjoyment of their property, nor injurious to the rights of the community. All property in this commonwealth, as well as that in the interior, as that bordering on tidewaters, is derived directly or indirectly from the government and held to those general regulations, which are necessary to the common good and general welfare. Rights of property, like all other social and conventional rights, are subject to such reasonable limitations in their enjoyment as will prevent their being injurious, and to such reasonable restraints and regulations established by law as the legislature, under the governing and controlling power vested in them by the constitution, may think necessary and expedient." And, on pages 95 and 96, he says: "Wherever there is a general right on the part of the public, a general duty on the part of the land owner, or any other person to respect such right, we think it is competent for the legislature, by a specific enactment, to prescribe a precise practical rule for declaring, establishing and securing respect for it. It may be said in general terms, independently of any positive enactment, that it is the right of society in the midst of a populous settlement to be exempt from the promixity of dangerous and noxious trades, and that it is the duty of the owner of real estate, in the midst of many habitations, to abstain from erecting buildings thereon, or otherwise using it for carrying on a trade dangerous to lives, health or comfort of the inhabitants of such dwellings, although a trade in itself beneficial and useful to the public.

"But such general duty and obligation not being fixed by a rule precise enough for practical purposes, we think it competent for the legislature to interpose, and by a specific enactment to declare what shall be a dangerous and noxious trade, under what circumstances and within what distance of habitations it may or shall not be set up, how the use of it shall be regulated and to prohibit any other than such regulated use by specific penalties."

So Freund, section 619, page 641, speaks of regulations of cutting of forests to prevent injuries from floods, and cites Commonwealth *vs.* Tewsbury, II Metc. 55, in which the question arose as to the right to prohibit by statute a proprietor of private land from removing gravel, stone or sand from the sea front of his property as liable to produce overflow from the sea, and the statute was sustained.

So in 7 Cushing, 55, the same statute was sustained, and on page 57 the Supreme Court of Massachusetts said: "All property is acquired and held under the tacit condition that it shall not so be used as to injure the equal rights of others or to destroy or greatly impair the public rights and interests of the community, under the maxim of the common law *sic utere tuo ut alienum non laedas.*"

Prentice on Police Power says on page 88: "Incidentally the game laws have aided the great reform of preventing not only the destruction of forests but also the pollution of streams." [Control of Private Property for Public Interest, see Prentice, pages 29, 42, 58, 89, 177, 347 and 456.]

"In this country it would probably be a strong consideration against legislation prescribing the principles of observance or principles of foresty in the management of private forests that there is no analogy or precedent for it, unless it can be shown that the supply of forest land was limited, and in danger of exhaustion, and that the regulation was not destructive to the lands of the owner." [Freund on Police Power, section 433, page 499.]

"Forests which are essential to the physical protection of the country may be regarded as subject to a natural easement for that purpose, and the person who acquires them takes them *cum onere.*" [Freund, section 423, page 450.]

The legal questions here under consideration were brought directly and specifically before the Supreme Court of the State of Maine by a resolution adopted by the senate of that state, March 27, 1907. The senate desired to know whether the legislature had the power, under the constitution of the state, to take measures for preventing or diminishing injurious droughts and freshets, for protecting the natural water supply of the springs, streams, ponds and lakes of the state, and for diminishing injurious erosions of the land and the filling up of streams and lakes, by adopting laws intended to accomplish the following results:[2]

1. To regulate or restrict the cutting or destruction of trees growing on wild or uncultivated land by the owner thereof without compensation thereof to such owner;

2. To prohibit, restrict or regulate the wanton, wasteful or unnecessary cutting or destruction of small trees growing on any wild or uncultivated land by the owner thereof, without compensation therefor to such owner, in case such small trees are of equal or greater actual value standing and remaining for their future growth than for immediate cutting, and such trees are not intended or sought to be cut for the purpose of clearing and improving such land for use or occupation in agriculture, mining, quarrying, manufacturing, or business, or for pleasure purposes, or for a building site; or

3. In such manner to regulate or restrict the cutting or destruction of trees growing on wild or uncultivated lands by the owners thereof as to preserve or enhance the value of such lands and trees thereon, and protect

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[2] 103 Maine reports, 507.

and promote the interests of such owners and the common welfare of the people.

On the 10th of March, 1908, the Maine Supreme Court replied to the request of the senate by an advisory opinion in which the court held that[8]

> The legislature of Maine has by the constitution of Maine full power to make and establish all reasonable laws and regulations for the defense and benefit of the people of this state, not repugnant to this constitution, nor that of the United States.
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> It is for the legislature to determine from time to time the occasion and what laws and regulations are necessary or expedient for the defense and benefit of the people; and, however inconvenienced, restricted or even damaged, particular persons and corporations may be, such general laws and regulations are to be held valid, unless there can be pointed out some provision in the state or United States constitution, which clearly prohibits them.
>
> Legislation to restrict or regulate the cutting of trees on wild or uncultivated land by the owner thereof, etc., without compensation therefor to such owner, in order to prevent or diminish injurious droughts and freshets, and to protect, preserve and maintain the natural water supply of springs, streams, ponds and lakes, etc., and to prevent or diminish injurious erosion of the land and the filling up of the rivers, ponds and lakes, etc., would not operate to "take" private property within the inhibition of the constitution.
>
> While such legislation might restrict the owner of wild and uncultivated lands in his use of them, might delay his taking some of the product, might defer his anticipated profits and even thereby might cause him some loss of profit, it would nevertheless leave him his lands, their product and increase, untouched and without diminution of title, estate or quantity. He would still have large measure of control and large opportunity to realize values. He might suffer delay but not deprivation. While the use might be restricted, it would not be appropriated or "taken." Such legislation would be within the legislative power and would not operate as a taking of private property for which compensation must be made.

Thus the Supreme Court of Maine holds that its state unquestionably has the power to regulate the cutting and use of timber upon lands privately owned.

The legal principles enunciated in this decision of the Supreme Court of Maine are further elucidated by a decision of the United States Supreme Court, rendered upon the 6th of April, 1908. The case before the United States Court was one brought before it upon an appeal from the decision of the Court of Errors and Appeals of the State of New Jersey. In 1905, New Jersey passed a law enacting that

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[8] 103 Maine reports, 506.

> It shall be unlawful for any person or corporation to transport or carry through pipes, conduits, ditches or canals, the waters of any fresh water lake, pond, brook, creek, river or stream of this state into any other state for use therein.

After the passage of this law the owners of land upon the Passaic River, New Jersey, made a contract with the City of New York to furnish a supply of water adequate for the needs of the Borough of Richmond. The carrying out of this contract was prohibited by an injunction issued by the Chancellor of the State[4] which injunction was affirmed by the Court of Errors and Appeals,[5] from which court the case was brought before the United States Supreme Court. This court of final appeal, in an opinion delivered by Mr. Justice Holmes, again affirmed the injunction and thus held the New Jersey statute to be valid.

Although the question before the court in this New Jersey case involved the right to use the waters of the state, the principles upon which Justice Holmes based his decision are as applicable to the government regulation of privately owned forests as to the use of waters of the state. The learned justice stated in the decision that[6]

> The boundary line between private rights of property which can only be limited on compensation by the exercise of eminent domain, and the police power of the state which can limit such rights for the public interest, cannot be determined by any formula in advance, but points in that line helping to establish it had been fixed by decisions of the court that concrete cases fall on the nearer or farther side thereof.
>
> The state, as *quasi*-sovereign and representative of the interests of the public, has a standing in court to protect the atmosphere, the water and the forests within its territory, irrespective of the assent or dissent of the private owners immediately concerned. *Kansas* vs. *Colorado,* 185 U. S. 125; *Georgia* vs. *Tennessee Copper Co.,* 206 U. S. 230.
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> The public interest is omnipresent wherever there is a state, and grows more pressing as population grows, and is paramount to private property of riparian proprietors . . . .

[4] 78 N. J. Eq. 525.
[5] 70 N. J. Eq. 695.
[6] 209 U. S. 349.

A state has a constitutional power to insist that its natural advantages remain unimpaired by its citizens and is not dependent upon any reason for its will so to do.

The extent of the powers possessed by the states for the regulation of privately owned forests cannot as yet be said to have been definitely determined. The foregoing analysis clearly indicates that the state and federal courts are disposed to interpret the powers of the states liberally, and it seems probable that the constitution of the federal government and the constitutions of the states will be held to permit the states to take such measures for the protection of their forests and the conservation of their other natural resources as may be demanded by present economic needs and as may be required in the interest of the future welfare of society. If this conclusion be correct, the government regulation of private forests may be considered to be primarily a question of expediency and not of constitutional law.

PART TWO

Water Resources and Water Power

WATER AS A RESOURCE

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WATER POWER IN THE UNITED STATES

BY M. O. LEIGHTON,

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THE SCOPE OF STATE AND FEDERAL LEGISLATION CONCERNING THE USE OF WATERS

BY CHARLES EDWARD WRIGHT,

Assistant Attorney to the Secretary of the Interior, Washington, D. C.

NECESSITY FOR STATE OR FEDERAL REGULATION OF WATER POWER DEVELOPMENT

BY CHARLES WHITING BAKER, C.E.,

Managing Editor, "Engineering News," New York City.

FEDERAL CONTROL OF WATER POWER IN SWITZERLAND

BY TREADWELL CLEVELAND, JR.,

Forest Service, Washington, D. C.

WATER AS A RESOURCE

By W. J. McGee, LL. D.,
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Current Tendencies

This is an age of science and ours a nation of science. Observation has matured in measurement and passed from the qualitative to the quantitative, generalization is a habit, and prevision has become a commonplace in current life. More than all else, the course of nature has come to be investigated in order that it may be re-directed along lines contributing to human welfare; invention has become a step toward creation, and is extending far beyond the merely mechanical and into the realms of the chemical and even the vital. Now is the time of conquest over nature in practical sense, of panurgy in philosophic sense—the day of prophecy made perfect in predetermined accomplishment.

Our country is growing rapidly. The rate varies along different lines. Our growth in agricultural production is unprecedented in the world's history; our growth in population is so much more rapid that exportation of food-stuffs is declining; our growth in mining outruns our increase in population; our growth in manufacturing far exceeds that in mining, and our growth in application of mechanical power is much more rapid than our advance in manufacturing. Along one line only is our growth more rapid than in the use of power—*i. e.*, in that knowledge and mental capacity required to guide and develop the material progress.

Our rate of mental growth is not easily measured in that its manifestations are manifold. In 1905 it was pointed out that along the single line of university development the rate of advance is geometric—that during the first half of the nineteenth century our university strength measured in endowments, or faculties, or students, or alumni, or all combined doubled; that during the next quarter-century it doubled again; that from 1875 to 1890 it doubled again; that in the next decade it once more doubled, and that within the first seven years of the present century it would inevitably double again. Naturally such whelming growth can not continue indefinitely on any line; yet the advance can and does continue, largely by the development of new lines or by multiplication of the old, so patently that it is safe to characterize our progress in knowledge and mental power as geometric.

Our growth in knowledge of that definite character called science is notable—particularly in its ever-multiplying applications. Twenty-five years ago the writer compiled a geologic map of the United States, the first based wholly on observation and not at all on inference, and although a quarter of the area was left blank, it was complete enough for publication;[1] a year later he compiled the first map showing the distribution of coal in the United States, which was fairly complete for two-thirds of our area yet so incomplete for the remaining third as not to be deemed worthy of publication. The facts that to-day any geologic map may be made substantially complete, and that our coal deposits have been surveyed not only as to area but as to volume, strikingly illustrate the rapidity and sureness of our progress in practical knowledge.

With the growth of science, its field has extended and its agencies have multiplied. When the Federal Geological Survey was started and the State surveys were reinvigorated only three decades ago, they stood almost alone for the development of the natural resources, aside from the land reckoned in area merely. Now the surveys have grown; an entire Federal Department and corresponding State instrumentalities have come up on the basis of resources comprising the land and its products and potentialities, a wide range of minerals, the forests which protect the streams, and of late the water itself. It is in harmony with the general development that the quantitative method is now applied not only to soil production in forests and crops, and to mine production and minerals in the ground, but finally to the rains and rivers which render the land habitable and the ground waters which render it fruitful.

No more significant advance has been made in our history than that of the last year or two in which our waters have come to be considered as a resource—one definitely limited in quantity, yet susceptible of conservation and of increased beneficence through wise utilization. The conquest of nature, which began with progressive control of the soil and its products and passed to the minerals, is now extending to the waters on, above and beneath the surface. The conquest will not be complete until these waters are brought under complete control.

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[1] It appeared under the title "Map of the United States exhibiting the present *status* of knowledge of the geological groups." Fifth Annual Report of the U. S. Geological Survey, 1885 (pages 36-38, plate II).

Units of Measure

The quantitative view of water, except in smaller measures, is so new to thought that familiar units are lacking. Municipal water supply is generally expressed in gallons, irrigation water in acre-feet, stream flow in second-feet, or more accurately seconds-feet, and water for certain uses in the variable and indefinite miners'-inch. There is urgent need of a unit applicable to the quantities commonly used for water supply, irrigation and various other purposes. Moderate familiarity with the metric system would render convenient as such a unit the stere, equivalent to the kiloliter or cubit meter, the virtual basis of the metric system for volume or tridimensional measure, which roughly approximates—like the liter the quart—the cubic yard in quantity and the ton in weight of water, while the kilostere approximates 1000 tons and an acre-foot. The kilostere is especially convenient in discussing the water supply of the United States in that it permits expression of the leading values in round numbers not too large for ready comprehension—the mean rainfall totaling six billion (6,000,000,000) kilosteres, and its main derivative fractions being expressible in sixths of this total.[2]

Pending adoption of the metric unit, and as a glaring illustration of the need, it is necessary to employ either the cubic foot or the cubic mile in dealing quantitatively with our water supply—preferably the former for the supply of a country, the latter for the water of the world; and it is desirable to crystallize the quantitative concept by using the units interchangeably and coupling both with the metric system.

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[2] A few of the equivalents involved in the use of the stere follow:

1 liter equals 0.26 gal., 61.02 cu. in., 2.2 lbs.

1 stere equals 1000 liters, 1 kiloliter, 1 cubic meter, 264.17 gals., 35.31 cu. ft., 2204.62 lbs.

1 kilostere equals 1000 kiloliters, 264,170 gals., 35.314 cu. ft., 0.81 acre-foot, 1102.3 tons.

1 gal. equals 3.785 liters, 0.134 cu. ft., 231 cu. in., 8.313 lbs.

1 cu. ft. equals 28.32 liters, 0.028 kiloliters, 7.48 gals., 62.43 lbs.

1 cu. mi. equals 147.197.952.000 cu. ft., 4,168,207 kilosteres, 3,379,165 acre-feet 4,594,656,258 tons.

1 ton equals 907 liters, 0.907 kiloliter, 240 gals., 32 cu. ft. 2000 lbs.

I lb. equals 0.45 liter, 0.12 gal., 27.7 cu. in.

OUR STOCK OF WATER

The World Supply

The water of the world (or hydrosphere) is about 1/600 of the globe, or some 410,000,000 cubic miles. Nearly three-quarters occupies depressions in the earth-crust as seas; about a quarter, or some 100,000,000 cubic miles, permeates earth and rocks as ground water; the remaining small fraction is gathered in fresh-water lakes and channels, accumulated in snow and ice, or distributed in the atmosphere as aqueous vapor.

The mean annual precipitation is about 30,000 cubic miles ±4,400,000,000,000,000 cubic feet ±125,000,000,000 kilosteres ±100,000,000,000 acre-feet over the lands of the globe, and 90,000 cubic miles on the oceans—in all, 120,000 cubic miles ±17,600,000,000,000,000 cubic feet ±500,000,000,000 kilosteres ±400,000,000,000 acre-feet.

The vapor in the atmosphere tempers the climate; without it the globe would be uninhabitable. The average quantity is probably much less than the mean annual precipitation.

The sole source of the fresh waters of the world is the precipitation, mainly in rain, partly in snow, slightly in mist and fog; without it the lands would be barren, the earth a dead planet.

The most active part of the world's water is the small fraction forming streams; these, with some help from glacier ice, have sculptured nearly all of the land surface of the globe, collected materials for the geologic formations, and shaped the continents—running water being by far the most important earth-building agency.

The most effective portion of the water in the organic world is the minute fraction circulating through structures and maintaining the vital processes—for water is the primal constituent and primordial source of living things.

National Supply

The mean annual precipitation on the territory of mainland United States is about 30 inches; the quantity falling on the land with the included water areas is about two hundred and fifteen trillion (215,000,000,000,000 cubic feet ±1500 cubic miles ±6,000,000,000 kilosteres ±4,800,000,000, acre feet. It is equivalent to ten Mississippi rivers. From this source all our running, standing and ground waters are derived.

The yearly rainfall on the more humid two-fifths of the country east of the ninety-fifth meridian, or what may be called the state divide forming the eastern boundary of the five median states—North Dakota, South Dakota, Nebraska, Oklahoma and Texas, is nearly 48 inches; the quantity about 140,000,000,000,000 cubic feet ±1000 cubic mills ±4,000,000,000 kilosteres. On the semi-arid fifth of our area in these median states, or between the ninety-fifth and hundred and third meridians, the rainfall averages 30 inches and aggregates some 40,000,000,000,000 cubic feet. The rainfall on the western two-fifths of the country, including our arid lands, averages about 12 inches, or about 35,000,000,000,000 cubic feet ±250 cubic miles ±1,000,000,000 kilosteres.

Of the total rainfall, over half is evaporated; about a third flows into the sea; the remaining sixth is either consumed or absorbed. These divisions, which may be called respectively the fly-off, the run-off, and the cut-off are partly interchangeable. About a third of the run-off, or a tenth of the entire rainfall, passes through the Mississippi. The run-off is increasing with cultivation and deforestation; that of the Mississippi has increased from some 19,500,000,000,000 cubic feet as measured by Humphreys and Abbott fifty years ago to over 22,000,000,000,000 cubic feet as recently gauged by Leighton. It is wholly within reach of human control.

The 110,000,000,000,000 cubic feet (3,000,000,000 kilosteres) of fly-off affects agriculture and other industries largely through climate. Except in moderate degree through scientific agriculture and forestry, it is beyond artificial control.

The 70,000,000,000,000 cubic feet (2,000,000,000 kilosteres) of run-off is available for water supply, irrigation, navigation and power. It is controlled in small part, and may be wholly controlled by proper means.

The remainder of the rainfall (the 35,000,000,000,000 cubic feet or 1,000,000,000 kilosteres of cut-off) is either consumed in plant growth and other chemical combinations, or else permeates the deeper strata and passes subterraneously into the sea. It is partly controlled, chiefly through farming and forestry, and the control may be much increased.

OUR USE AND WASTE OF WATER

The Fly-off

Of the hundred and ten trillion (110,000,000,000,000) cubic feet ±750 cubic miles ±3,000,000,000 kilosteres of water annually evaporated in mainland United States, incidental use is made through the settlement and industrial development depending on the presence of aqueous vapor in the atmosphere. Much of it is re-precipitated, generally after an easterly movement; perhaps half of the vapor content of the air, and the precipitation, *e. g.*, at St. Louis is derived from the Pacific primarily and from original precipitation and evaporation within the arid and semi-arid regions secondarily; the other moiety coming from the Gulf of Mexico. Neither the quantity nor the relations of the fly-off are known accurately; systematic observations and records of evaporation in different regions and under varying conditions have only recently been undertaken by the Weather Bureau. Evaporation is rapid from trees and many crop plants by reason of transporation. Probably it is less rapid from water surfaces and still less from grass lands or bare earth and rock, in which the water is held by molecular attraction and surface tension. Recent investigations in the Forest Service and the Hydrographic Branch of the Geological Survey render it clear that deforestation, *e. g.*, in the Ohio Valley, is followed by diminished precipitation, doubtless by reason of reduced sub-local evaporation, *i. e.*, that the aqueous vapor and circulation are interdependent with surface conditions and hence measurably subject to control. The fly-off is adapted to largely increased population and industries.

The Run-off

Of the seventy trillion (70,000,000,000,000) cubic feet ±500 cubic miles ±2,000,000,000 kilosteres annually flowing into the sea, little more than 100,000,000,000 cubic feet ±2,800,000 kilosteres, or one-seventh of one per cent., is taken from rivers and lakes and protected catchment areas for municipal and community supply and related purposes; less than two per cent., or some ten per cent. of that in the arid and semi-arid regions, is used for irrigation; perhaps five per cent. may be reckoned as in small use for navigation; and less than five per cent. is utilized for power. It is estimated that eighty-five per cent. to ninety-five per cent. of the volume is wasted in freshets or destructive floods.

It is reckoned by M. O. Leighton, Chief of the Hydrographic Branch of the Geological Survey, that for municipal and community water supply there are protected catchment areas aggregating over 1,000,000 acres, and that fully $250,000,000 are invested in waterworks with nearly as much more in the appurtenant catchment areas and other lands. The population so supplied approaches 10,000,000; the annual consumption is about 37,500,000,000 cubic feet ±1,000,000 kilosteres, or one-twentieth of one per cent. of our run-off. The better managed systems protect the catchment areas by forests or grass; the water is completely controlled, the storm product is stored, and there is little waste save through over-lavish use after the impounded flow enters the mains.

For irrigation it is estimated by Director Newell, of the Reclamation Service, that there are $200,000,000 invested in dams, ditches, reservoirs and other works for the partial control of the waters, in addition to the value of the land which is virtually fixed by the availability of the water; and that 1,500,000,000,000 cubic feet ±42,000,000 kilosteres—*i. e.,* three-quarters of one per cent. of our total rainfall, or two per cent. of that on the western two-fifths of our area—are annually diverted to irrigable lands aggregating some 13,000,000 acres. Except in some cases through forestry, there is little effort to control the catchment areas, and few reservoirs are large enough to hold the storm waters; so that the waste in public and private projects exceeds sixty per cent., while less than twenty-eight per cent. of the water actually available for irrigation of the arid lands is restrained and diverted.

There are in mainland United States 287 streams navigated for an aggregate of 26,226 miles,[3] and about an equal additional mileage might be made navigable by waterway improvement; there are also forty-five canals with a mileage of 2189, besides numerous abandoned canals.[4] On lake and sound routes there is a large traffic, but the navigation of rivers and canals is too small for definite record. Several hundred million dollars have been expended on special projects, yet "in spite of large appropriations for their improvement, our rivers are less serviceable for interstate commerce to-day than they were half a century ago."[5] The cost of water carriage averaging about one-fourth that of rail carriage, and our railway freightage during 1906 reaching 217,000,000,000 ton-miles at an average rate of 0.77 cent, the shipping of one-fifth of our freight by water would have saved over $250,000,000 to our producers and consumers. Except through forestry in recent years, together with a few reservoirs and canal locks and movable dams, there has been little effort to control headwaters or catchment areas in the interests of navigation; and none of our rivers are navigated to more than a small fraction even of their effective low-water capacity.

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[3] Preliminary Report of the Inland Waterways Commission, 1909. Herbert Knox Smith, on "Navigable Streams of the United States," page 35.

[4] *Ibid.* Herbert Knox Smith, on "Canals in the United States," page 190.

The theoretical power of the streams is reckoned by Leighton at 230,000,000 horse power. The amount now used is computed by the Census Office at 5,230,000 horse power, and the amount running over Government dams and not used is estimated by the Chief of Engineers at about 1,400,000 horse power. The amount now available at a cost comparable with that of steam installation is estimated by the Hydrographic Branch of the Geological Survey at 37,000,000 horse power, and the amount prospectively available at 75,000,000 to 150,000,000 horse power. The 37,000,000 horse power to-day available exceeds our entire mechanical power now in use, and would operate every mill, drive every spindle, propel every train and boat, and light every city, town and village in the country. The nominal value is $20 per horse-power year; the price ranges up to $100 or $150. While the utilization of water power ranks among our most recent and most rapid industrial developments, little effort has been made to control catchment areas or storm waters in any large way for power development; though most plants effect local control through reservoirs and structures. Nearly all of the freshet and flood water runs to waste, and the low waters which limit the efficiency of power plants are increasing in frequency and duration with the increasing flood run-off.

The practical utility of streams for both navigation and power is measured by the effective low-water stage; the volume carried when the streams rise above this stage, seventy-five to ninety per cent. of the run-off, is not only wasted, but does serious damage. The direct yearly damage by floods since 1900, as computed by Leighton, has increased steadily from $45,000,000 to $238,000,000; the indirect loss through depreciation of property is probably greater; while the largest loss is that arising in impeded navigation and terminal transfers.

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[5] Preliminary Report of the Inland Waterways Commission, 1909. "Message of the President," page vi.

The freshets are attended by destructive soil erosion. The soil matter annually carried into lower rivers and harbors or into the sea has recently been reckoned by Dole and Stabler at 783,000,000 tons. Its removal seriously reduces the productivity of upland farms and increases channel-cutting and bar-building in the rivers. It is estimated that soil erosion reduces farm production ten to twenty per cent., that annual loss to farms alone is $500,000,000, and that large losses follow the fouling of the waters and the diminished navigability of the streams.

Through imperfect control of the running waters, lowlands are temporarily or permanently flooded. It is estimated that there are in mainland United States 75,000,000 to 80,000,000 acres of overflow and swamp lands requiring drainage; that by systematic operations these might be drained and the water made available at moderate expense; and that they would then be worth two or three times the present value and cost of drainage, and would furnish homes for 10,000,000 inhabitants.

A part of the run-off lodges temporarily in lakes and ponds. It is estimated that the quantity of fresh water so stored, including the American portion of the Great Lakes, is about 600,000,000,000,000 cubic feet ±45,000 cubic miles ±28,000,000,000 kilosteres, equivalent to three years' rainfall or nine years' run-off. The natural reservoirs yield a water supply ordinarily requiring no control of catchment area. Some 6,000,000 of our people draw their water supply from lakes. All the larger and deeper lakes are navigated; they serve the chief part of our inland commerce by water.

The Cut-off

Of the thirty-five trillion (35,000,000,000,000) cubic feet ±250 cubic miles ±1,000,000,000 kilosteres of cut-off, the chief share is absorbed by soil and earth or consumed by natural processes or through agriculture and related industries; yet most of it returns to the original supply by natural circulation.

On an average the plant tissue of annual growths is three-fourths and of perennial growths three-eighths water; of human and stock food over eighty per cent. is water, and in animal tissue the ratio is about the same; and is the chief vehicle for the transmission of enteric and many other diseases. Since water is the essential circulatory medium in organic bodies, the plants and animals of the country yearly require an amount many times exceeding their aggregate volume; the average man of 150 pounds ingests over a ton (900 liters, thirty-two cubic feet, or thirteen times his volume) of water each year, and an average bushel of corn requires over 700 cubic feet (twenty kiloliters or twenty-two tons) of water in the making—of which the larger part is evaporated. Even in the more humid sections of the country, the productivity of the soil and the possible human population would be much larger if the rainfall were greater, leaving a wider margin for organic and other chemical uses. Except through irrigation, little general effort is made to control the natural circulation, though some farmers in arid regions claim to double or triple the crop from given soil by supplying water just when needed and withholding it when not required.

The greater part of the cut-off lodges temporarily in the soil and earth as ground water. According to texture, fire-dry rocks contain one to three per cent., air-dry rocks five to twenty-five per cent., and saturated rocks and earths ten to forty per cent. of water, while the optimum moisture for plant growth in top-soil ranges from four to twenty per cent.; and it is estimated that the ground water to the depth of 100 feet in which it is available for hand pumps and capillarity and deep-rooted trees averages five per cent. over 1,000,000 square miles, twenty per cent. over another third of the country, and twenty-five per cent. over the remaining third—a mean of 16 2/3 per cent. This ground water may be conceived as a sub-surface reservoir 3,000,000 square miles in area and nearly seventeen feet deep, containing over 1,400,000,000,000,000 cubic feet ±100,000 cubic miles ±40,000,000,000 kilosteres, equivalent to seven years' rainfall or twenty years' run-off. It is the essential basis of agriculture and most other industries, and the chief natural resource of the country; it sustains forests and all other crops, and supplies the perennial streams and springs and wells used by four-fifths of our population and nearly all our domestic animals. Its quantity is diminished by the increased run-off due to deforestation and injudicious farming. Throughout the upland portions of eastern United States the average water-table has been lowered ten to forty feet, so that fully three-fourths of the springs and shallower wells have failed and many brooks have run dry, while the risk of crop loss by drought has proportionately increased, and the waste through the Mississippi has increased over fifteen per cent. Although the available ground water is subject to control by such treatment of soil and plant growth as to prevent freshets, little effort has been made to retain it or increase its volume, and it is probable that fully ten per cent. of rich resource has been allowed to drain away since settlement began. The water of the deeper rocks below 100 feet supplies artesian and other deep wells, most thermal and mineral waters, and many large springs; it may be controlled in part through the sub-surface reservoir, and might be much better utilized.

In both ground and organisms the water, except when frozen, is in constant movement. In the soil it moves under gravity and capillarity, dissolves earth-salts and conveys them into and through the circulatory systems of living plants, and then carries the katastates of growth and decay into the air or back into the earth matter to hasten its solution. Some of the organic derivatives are excretory and poisonous to the plants yielding them or to others, but many of them set up destructive decompositions yielding elements of fertility, such as nitrogen and potassium and phosphorus compounds, serving to sustain later generations of plants; some of the earth-salts, such as calcium compounds, carried by the circulating waters promote the flocculation of particles and the friability of the soils on which plant growth depends; so that the primary law of the soil is one of cumulative enrichments through interaction of the floras and faunas by means of the aqueous circulation.

In plants the irregular circulation and in animals the regular circulation are maintained chiefly by transpiration and respiration, respectively, *i. e.*, by the passage of the water from liquid to vapor—and there is neither metabolism nor germination, nor any other essentially vital action, in the absence of water as the fundamental circulatory medium. The circulation extends from the organism into the air above and the soil below, with a degree of energy measured by evaporation, condensation, latency and affinity; and the locus of most effective energizing on the planet is the infinitely complex surface of the soil with its component particles and its extensions in living organisms at which water is continually passing from one form to another in endless circulatory progression. This surface—the chief theater of organic activity—is subject to human control, partly through management of the soil, partly through selection and modification of the organisms, chiefly through regulation of the movements of the water derived from the rains and lodged in the sub-surface reservoir. Through control of this surface our entire water supply may be saved and applied to beneficial uses.

Our Most Urgent Needs

Our stock of water is like other resources in that its quantity is fixed. It differs from such mineral resources as coal and iron, which once used are gone forever, in that the supply is perpetual; and it differs from such resources as soils and forests, which are capable of renewal or increase, provided the supply of water suffices, in that its quantity can not be augmented. It differs also in that its relative quantity is too small to permit full development of other resources and of the population and industries depending on them. Like all other resources, it may be better utilized. It must be better utilized in order to derive full benefit from lands and forests and mines.

Although our rainfall of 215,000,000,000,000 cubic feet is 2,500,000 cubic feet per capita for a population of 86,000,000, or 250,000 cubic feet, allowing for the ninety per cent. waste, our growth in population and industries is seriously retarded by dearth and misuse of water. Fully a third of our territory, 1,000,000 square miles, the area of Great Britain, Germany, France, Spain, Portugal, Italy, Austria and Denmark combined, remains practically unoccupied and nearly unproductive by reason of aridity; while the public lands sufficiently humid for agricultural settlement are taken, the cost of transportation is limiting production, and our citizens are emigrating in thousands to other countries. With half our land area and the same water, our capacity for population and industries would be as great as now; with twice our water equally distributed over our present land, our capacity would be more than doubled.

Hitherto water has seldom been regarded as a resource to be exploited and conserved; it has been viewed vaguely as a prime necessity, yet merely as a natural incident or providential blessing. In its assumed plentitude the idea of quantity has seldom arisen though the waste is least in those arid regions in which customs are better adjusted to the values and inter-relations of water. Under the English common-law prevailing in eastern United States, the water is held appurtenant to the land; under the Code Napoleon prevailing in Louisiana, it virtually appertains to the community; under the Spanish-Roman law prevailing in western United States, water is subject to prior appropriation and beneficial use, and hence appertains primarily to the individual or family, while the land is essentially appurtenant to the water traversing it. Some States recognize a residuary right of the people in the natural waters, or in the headwaters of streams used for water supply or navigation, and this recognition seems to be extending over the country; but the usage of the different sections is not uniform, the exercise of the right of the people generally varying with the aridity of the land or the density of the population.

In considering the benefits to be derived from the 215,000,000,000,000 cubic feet of water annually received, the paramount use should be that of water supply; next should follow navigation in humid regions and irrigation in arid regions. The utilization of power from the navigable and source streams should be kept subordinate to the primary and secondary uses of the waters; though other things equal, power development should be encouraged, not only to reduce the drain on other resources, but because properly designed reservoirs and power plants retard the run-off and so aid in the control of the streams for navigation and other uses.

It has been roughly estimated that the inland waterways of the country could be improved in ten years at a cost of $50,000,000 annually in such manner as to promote interstate commerce and at the same time greatly reduce the waste and extend the use of the waters. If done at the cost of the people, the burden would be $0.62½ per capita per year, or $6.25 in all, for a population of 80,000,000.

It is roughly estimated that the direct benefits would comprise an annual saving in transportation of $250,000,000; an annual saving in flood damage of $150,000,000; an average annual saving in forest fires of at least $25,000,000; an annual benefit through cheapened power of fully $75,000,000; and an annual saving in soil erosion or corresponding benefit through increased farm production of $500,000,000—a total of $1,000,000,000, or $12.50 per capita annually, *i. e.*, twenty times the cost. In addition, large benefits would result from extended irrigation, from the drainage and settlement of swamp and overflow land, and from purified and cheapened water supply with consequent diminution of disease and saving of human life.

It is estimated that the income derived from power developed by works for the improvement of navigation, if utilized at current market rates in co-operation with states and citizens, would alone compensate the entire cost of maintenance and continued development after the initial expenditure of $500,000,000 as a working capital.

WATER POWER IN THE UNITED STATES

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The people of the United States must give up their leadership in the productive world when they shall have placed in use all their sources of cheap mechanical energy.

Present-day leadership in the productive world must be based on energy. This energy must, in the first place, be an inherent quality of the people and, in the second place, there must be an abundant external supply which the people can harness and subdue. Whatever amount of one there may be, there can be no leadership of long standing without a fully proportional amount of the other. The converse is quite as true. The American people possess limitless inherent energy; therefore their industrial progress must be dependent upon the amount of external power that they can command. This progress can continue up to a point at which the cheap power is all placed in use. Thereafter the best that our people can do is to hold fast. But such a condition is unstable. Some other people making skillful and energetic use of a larger amount of power would not only take the leadership but, in conformity with the scriptural "Parable of the Talents," they would by virtue of their larger possession take from our people that which they already have. It is a faithful saying that a halt in progress marks the beginning of a backward movement.

The finding out of what kind and of how much mechanical energy there is ready for use in this country is the first step in shaping our future industrial expectations. The process of the finding therefore becomes one of our most important matters of public duty. If our promised needs for mechanical energy bid fair in the near future to consume or to utilize all our sources of power, then will it be a part of wisdom to approach that crisis with our eyes open. On the other hand, if our sources are so vast that the end may not be reached for many generations, then our problem is reduced to a wise selection of the best and most econmical use of that which we have.

Two main points should be borne in mind: First, that we shall make full use of the kind of power that will finally be the cheapest; second, that we shall be as miserly in the use of our sources of energy that become impoverished in the using as is consistent with final efficiency and purposeful results. The mere possession of great sources of mechanical energy will not insure industrial leadership. Each source must be properly harnessed. Having done this, it behooves us to have a care that we do not habitually burden our family driving horse with a load adapted to a percheron.

Leadership in the productive world may depend upon the wisdom with which the sources of mechanical energy are chosen, quite as much as upon the skill with which that energy is used.

As one generation follows another and leaves no gap between, so the methods and the tools of the one, being cheaper or more effective or less destructive than those of the other, gradually drive them from the field. It is necessary in the use of mechanical energy to choose that which is cheapest and most effective. It would be of little use for the people of one country to possess and to use a certain source of energy, be it ever so abundant, if that energy were not as efficient or were more costly than that used by the people of another country. Such a situation would merely suggest the comparison of two artisans, one of whom uses poor and the other good tools. If the people of this country persist in using a costly form of energy, which by the very use thereof hastens the final impoverishment of the available supply, they can not expect always to compete with the people of any other country who use a cheap and effective agent of mechanical power, which, moreover, is not impoverished.

The United States is using over 26,000,000 horse power produced by fuel and principally by the use of coal in steam boilers. Utmost ingenuity has been practiced by the engineering profession in the improvement of methods of steam production and utilization. The cost of installing a steam plant is comparatively small—far less than the first cost of a water-power plant of similar capacity. Moreover, it is easy and convenient to set up a steam power unit well suited to the transient demands and there is a certain satisfaction in the completeness and independence that it affords. Until yesterday or the day before, the steam plant was practically the only agent of power that could be the resort except in unusual and often inconvenient localities. All of these as well as sundry other considerations developed in the power user the steam boiler habit. That was but natural. The man who sought to establish himself in a manufacturing business wished to place himself on a profitable operating basis at the earliest possible time. He chose the cheaper power installations as a first investment, trusting that the profits of the business would justify him, even though his subsequent expenses of maintenance were higher than they would have been with water power. In other words, he preferred a small immediate expenditure to a small ultimate one. The steam plant fairly met the conditions, but it has all been the result of surpassing ingenuity and adaptation.

There are being used in this country only about five and one-half million horse powers developed by falling water. Especially in the earlier days do we fail to find anything like the degree of ingenuity in the adaptation of such power which we find in the use of steam. There is a good reason for this, which will be discussed later. That which it is desired to emphasize here is that, up to the day of electrical transmission, water power was used only where it was situated so conveniently and developed so cheaply that the economy was self-evident. Before the day of steam our manufacturing centers were located at water powers. After the development of the compound engine, power centers sprang up in the almost waterless plains. The industrial world went steam mad. What of the consequences?

There is no disposition to claim that the almost universal turn to steam was not based upon fundamental necessities. It was one of the reasons for our industrial advancement and it must ever mark an epoch in our civilization. But it was not without its detriment. The tide of industrial favor turned squarely away from water power. It was a dethroned monarch and few were those who gave it thought. Thus the steam habit became fixed, and so firmly does it hold sway that even in this day of electrical transmission, the steam tide is not checked. Steam plants are installed in utter forgetfulness of water-power possibilities. Such powers still await the engrossing attention that was in the earlier day bestowed on steam. In spite of all this, it is apparent to everyone who has examined into the situation that fuel power is more costly than water power. Therefore in persisting in the use of fuel power the people of the country have burdened themselves with an often needless tax. Such a tax must be a handicap. In the face of a world's progress, can we afford to carry a handicap? We are not the only progressive people on earth. There are other nations who will command our best efforts in the race, even if we are stripped for the fray. By turning to water power as their source of mechanical energy they will easily out-produce and under-sell us. It all rests on the wise selection of the cheapest source of energy; it is the parallel of the good and the poor tool.

Our stores of fuel are being consumed and the price thereof must increase.

The total amount of coal consumed in the United States from about 1814 to the close of the year 1908 is 7,279,734,143 tons. The increase in coal consumption is shown by the following statement:

ANNUAL CONSUMPTION OF COAL IN THE UNITED STATES.

1898	219,976,267
1899	253,741,192
1900	269,684,027
1901	293,299,816
1902	301,590,439
1903	357,356,416
1904	351,816,398
1905	392,722,635
1906	414,157,278
1907	480,363,424
1908	415,900,000

1895	193,117,530
1890	157,770,963
1885	111,160,295
1880	71,481,570

Our stores of coal have been well explored and those who know most about the situation say that, at our present rate of increase in consumption, all our coal will be gone before the middle of the next century, and some declare that the end will be seen during the present century. Now this may not seem important to the man who conceives that he has no duty beyond his day and generation, but he is mistaken even from his own standpoint. It is an inevitable natural law that whenever the supply of any commodity becomes reduced the price thereof must increase, and moreover the increase is progressive from the beginning of the impoverishment of that supply until the end. The coal supply and the price thereof form no exception to this law. The price of coal is lower to-day than it will be five years hence. The price of anthracite coal has increased until the limit has practically been reached, that is, so long as our bituminous coals remain at a price approximating the present market value, it will not be economical to pay more for anthracite coal than approximately the present market price. This is merely an economic adjustment between the thermal efficiency and the market price of the two kinds of coal, but it forcibly illustrates the fact that our demands upon the store of anthracite coal have already impoverished it to an extent that nearly drives it from the market at the present time.

As the cost of coal is the chief item in the cost of steam power, it follows that an increase in the price of coal must mean an increase in the cost of steam power, which will widen the margin of cost of steam over water power. The handicap imposed by excessive cost of steam power is a growing one. The greater our progress under steam power, the greater must be the unit price that we pay for such progress. The right way to meet this condition is to lessen the demand. This can best be done by supplying the people with mechanical energy from running streams.

Only a certain part of the coal that we consume is used for power generation. It is inevitable that for a long time in the future coal or similar fuel will be needed for mere heating purposes. Therefore there is a good reason for saving our coal supply, even though there is promise that it may not in the near future be needed for power generation. Although at the present time our methods of converting electrical energy into heat are too wasteful to be adopted on any large or general scale, we may reasonably expect that continued improvements in our methods of conversion will make a progressive reduction in our dependence on the use of fuel for heating purposes. But, even if our methods are improved faster than we may reasonably expect at the present time, it will be several centuries before all our use for fuel will be supplanted by another source of energy. It will be of interest to consider what proportion of the coal consumed in the year 1908 might have been saved had there been in this country a development of water power sufficient to supply the greatest reasonable and possible demand, due regard being given to considerations of market and cost of water-power development. Such a statement must be based on our present limits of electrical transmission and conversion and, broadly speaking, such limits must be confined to the use of water power for light and mechanical energy, with an efficiency limit of transmission at 150 miles.

At least one-third of the coal now used in the United States could be saved by the wise and considerate development of water power.

There are in use in the United States somewhat more than 26,000,000 horse powers produced from fuel, principally in the form of steam power. Not all of this power could be supplied from water-power plants. The reason for this is that there are many great steam-power centers located at points remote from great water powers. To supply large demands at those points, it would be necessary to transmit electrical energy over greater distances than can be done efficiently at present. The longest transmission in the United States is 220 miles, but this is accomplished only with a sacrificed economy. This power station is one of a connected chain from which energy is supplied to several centers of utilization. There are times when the demand at the most remote point in the system is greater than can be supplied by the near-by stations and it becomes necessary to make up the deficiencies by transmitting from the farthermost station, 220 miles distant. In other words, this transmission is the resort of necessity rather than the practice of economy. Those most familiar with the practical side of electric power transmission testify that under present conditions the line losses increase disproportionately beyond a distance of about 100 miles. Of course, longer transmission is fairly common and not without profit to the producer; but, on the other hand, the shorter transmission is far more profitable per kilowatt hour.

The conditions above stated would apply with force in case it were attempted to substitute electric power for all our present steam plants. The City of New York, for example, is probably the greatest center of mechanical power consumption in the United States, if not in the world. Water powers situated within the present limits of efficient transmission to this city would not supply more than a small part of the entire demand. This being the case, it is doubtful if it would pay to try to utilize that which might be supplied. Such condition will, of course, be corrected in the future. Improvements in the efficiency of wire transmission will surely be made. It appears to the author, after taking a general view of the entire country, that about eighty per cent. of the steam power used could be replaced by water power. Let us assume, for the sake of being conservative, that the amount is seventy-five per cent. This means that there are 19,500,000 horse powers, which presumably may be produced by water power. It is not meant by this that every unit included in this great substitution could immediately be put on a paying basis—far from it. The ultimate benefit must be derived from the system as a whole. The case resembles that of a great railroad system; some of the branches are operated at a loss and others at an immense profit. The algebraic sum of profits and losses for the whole system determines the ultimate profits. So in the present discussion we are considering water power from the broad standpoint of essential public economy. The subject is so great that the gimlet-hole view must be incomplete. The progress or poverty of any particular plant is not of immediate importance.

It is not an easy task to determine the average amount of coal used to produce a horse power throughout the year. Boilers and engines throughout the United States differ widely in efficiency. There is a similar variation in the heat-producing quality of our coals. Some of the power produced in steam plants is used only ten hours each day, and during the remaining fourteen hours little coal is used. Other plants are in practically constant operation. Therefore any estimate of the average consumption of coal per horse-power-year for the whole country must be subject to errors of individual judgment. All the facts having been considered, the author believes that ten tons per horse-power-year is fair and reasonable, and he will use this as the factor. Any person who believes another factor would be more suitable may change the following estimate accordingly. The 19,500,000 steam horse powers above named must have required the burning of 195,000,000 tons of coal in 1908, which is about forty-seven per cent. of our total production for that year. This figure presents a fair idea of the amount of coal that might be saved by the substitution of water power under present limits of efficiency in electric conversion and transmission. What do the people of the country pay for the privilege of using their coal in this manner?

The people of the United States are paying a high price for the privilege of impoverishing their coal resources.

We must now face the task of estimating how much more steam power costs than water power. Of course, the cost varies with the price of coal and with the ease with which water power may be developed in various parts of the country. Some water powers may be improved and operated at small cost, while others are so expensive that they can not be profitably built and operated at the present market price of power. This market price varies also. In the great Northwest, for example, the price of coal is high, while water powers, especially in Columbia River basin, may, as a rule, be established at a relatively low cost. On the other hand, in a coal-mining region, where coal can be purchased at a nominal price, the water power that can compete with a steam-power plant must be of unusual cheapness and efficiency. The conditions vary so widely that the best way to arrive at some basis of estimate is to select some area which fairly represents average conditions.

In the area so chosen coal should be comparatively cheap and water abundant. The author believes that such an area is defined by the State of New York. It is situated so near the Pennsylvania coal fields as to make the price of coal somewhat below the average. On the other hand, New York is bountifully supplied with water-power privileges. Therefore the relative cost of the two kinds of power in New York ought to afford a good as well as a very conservative factor for the entire country. The New York State Water Supply Commission, in making its third annual report in 1908, gave careful study to the relative advantage of water power over steam power and reported that "at a low estimate the advantage of water over steam power is at least $12.00 per horse power per year." Note that this is a "low estimate" for New York State, and note further that in this state steam power must be relatively cheap. Therefore it seems hardly possible that if this factor of $12.00 be used for the whole country, the total will be too high. Applied to the 19,500,000 H. P. above referred to, there is given the stupendous annual charge of $234,000,000 annually, which may be regarded as a penalty for using steam power. Supposing this amount were deposited annually to create a sinking fund, can there be any doubt that the principal sum would be sufficient to develop the equivalent amount of water power and also to pay the damages arising from the abandonment of steam plants as fast as they were worn out in service?

The menace to American industrial leadership is already on the horizon.

It has been stated that leadership in the productive world depends upon a wise choice of the source of mechanical energy to be utilized in such production. It ought to be clear that we, as a people, can not sustain this leadership if another people choose to pursue a policy that will place at the disposal of the manufacturing world a cheaper power than that which we supply. It behooves us to look about and see whether or not there is any indication that such a policy is present or prospective.

The situation in Switzerland[1] is not without its menace. The people there have awakened to the fact that, whereas their scenery is a great resource, greater possibilities lie in their water powers. They are developing these powers, with the professed purpose of attracting within their boundaries as large a number of industries as they can supply with motive power. Great plateaus and benches previously given over to agriculture are the prospective sites for such manufacturing plants. So wide of scope is the plan that those who revere the scenic beauties of Switzerland are becoming disturbed over the promised impairment thereof. The whole plan is one of national encouragement of industries. Is there anyone in the United States so confident of this country's industrial leadership as to assert that the wholesale development of those large and cheap powers in Switzerland will not seriously affect our status in the productive world? Trade and production are entirely cosmopolitan. The cheapest sources of energy are going to be used without reference to any particular flag if they are located in a region convenient to market. There could be found no point more accessible to all the great markets of Europe than the Republic of Switzerland. Nor is Switzerland alone in this practical advantage.

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[1] See paper in this volume on "Federal Control of Water Power in Switzerland," by Treadwell Cleveland, Jr.

France is making amazing strides in water-power matters and the appreciation of the public duty in this respect appears to be more acutely felt there than in almost any other country. There is proper recognition of the fact that electric transmission of water power has introduced a new and forceful element into the political economy of the Republic. Whereas, before transmission, water power was a local matter, appurtenant to the particular site at which it was located, it has become a matter of general and special utility and should be so treated in the administration of government. French law relative to water-power development has received careful consideration during the past few years, and new concepts relative to the rights of the state have been adopted.

The first proposed reform consists of the granting of concessions for the development of water power, in the same manner as concessions are granted for public or quasi-public works, these concessions being limited to a specified time and to a specified amount of power. The principles proposed as a basis for this reform are: first, that all the various uses of water power must be facilitated and encouraged simultaneously, because it is of the greatest advantage to distribute the power produced among the greatest possible number of uses; second, that engineers and representatives of all kinds of interests must be encouraged to make studies and propositions as to combinations and projects of every nature relative to the best uses of water power; third, that the power of concession must belong to the state, which alone is able to combine all available information and to settle difficulties arising among opposing interests, the state in this case being the central government of the Republic. This power of concession is to be exercised irrespective of all business and financial prejudice, in the sole effort to derive the greatest possible amount of benefit. In every case in which there is no general public interest that would be damaged thereby, and only in such case, such concession shall be granted in the following order of preference: to the province; to the county; to the private company. The fourth priciple is that the term of concession shall be as limited as possible in order that mistakes or defects may from time to time be corrected and that changes may be made to conform to modifications in conditions.

The broad proposal briefly outlined above indicates merely that the Government of France is entering upon a campaign of encouragement and development of water powers, with the sole purpose in view of making the greatest possible use of this, its most important source of mechanical energy. It is significant that so broad a principle of public control should have been propsed and it is to be assumed that the proposal was the result of careful consideration, supplemented by the ripe experience of the famous hydraulicians, both past and present, of that country.

Germany, Austria, Italy, Sweden and Norway do not lag behind France and Switzerland in making a bid for industrial leadership through the agency of water power. Not long since Norway diverted from the United States to its own borders a great manufacturing plant, the product of which is one of the most necessary commodities in modern trade, necessary in peace and indispensable in war. The sources from which the world is now supplied with that product are failing and the process of this great company will eliminate those sources from the market, whether they fail within a decade or a century. The possession of that industry within our borders would certainly have been of strategic importance, but because public policy in the encouragement of water-power development in the United States is not as favorable as that in Norway, the industry located there. Having utilized the sites that were ceded to it by the Norwegian Government, this company is now seeking another location on which it is proposed to make a larger water-power development than has ever been comprised in a single unit or group of units. There are in the United States numerous sites at which this demand for power could be supplied, but the same conditions prevail here now as prevailed at the time of selecting the first location. European countries, knowing the strategic value of the plant in time of war, are offering inducements and concessions. The company, for various reasons, not the least of which is patriotism, would prefer to locate in the United States; but it finds among the people here no disposition to meet the conditions imposed by the situation, and at the present writing it looks as though the plant would be located in either Germany, Switzerland or France. If our people do not take advantage of this opportunity, it is probable that at some time in the future the United States will be obliged to buy the most necessary element in national defence from an unfriendly power or through a mediator. There are real difficulties in the way of securing proper concessions to meet such an emergency as this. The country that has adopted a policy will always have the advantage of a country like ours, which has no policy save that of tolerance and license of the greed of individuals.

There is more than enough water power in the United States to fulfil every want that may reasonably be expected to arise in many generations.

When we sum up our power resources and try to find out how long they will serve our future needs, we must look at the matter from a viewpoint different from that taken by the promoter of to-day. He is seeking an investment that will return a profit, and the elements that enter into his considerations are immediate cost and immediate market. It is not pleasing to him to invest in a plant that promises remote profits, but he seeks the opportune combination of demand and supply. We, on the other hand, must have in mind the broader subject of public necessity and economy. Therefore, when we say that our available water power is so much, it should be understood that a part of that amount is not suited for immediate use, but will become useful when our demands have increased to a point at which the high cost of installation is warranted. Some day in the future, the water-power privileges that we now pass without a moment's consideration will be profitably utilized. With this principle in mind, let us estimate the extent of our power resources.

No complete survey has ever been made of the water powers of the United States. In some parts, the facts are well known; in others, we have only approximate data. Yet that which is hereinafter set down is accurate enough. The power afforded by any river may be stated in several ways, each of which is subject to interpretation. Rivers fluctuate in flow, and it follows that the power must vary according to the fluctuation. Therefore in stating the available power it is necessary to give the stage of the river at which the stated amount may be produced. It should be plain that the most useful power is that which will be continuous throughout the dryest year, and this is the amount that will be developed by the lowest flow. The usual expressions for the energy so produced are "minimum power" or "primary power."

Whenever the river is running above the minimum flow, the power that it will develop is increased. Usually, the period of minimum flow is short, sometimes continuing for only a week or two, and seldom does it occur for more than two or three months in humid regions. Therefore, during the greater part of the year the river will produce more than the primary power. This power in excess of the primary may often be used for purposes that do not require power during the entire year. When, for example, a manufacturing plant which runs only a part of the year can be regulated in operation so that the periods of high water may be utilized, then the use of the power in excess of the primary is of great value. There are many other conditions and circumstances under which excess power may be used to advantage. The power in excess of the primary is usually termed "secondary power."

One of the important studies previous to the construction of power plants is that of the limit to which secondary power can be economically developed. In some parts of the country it is profitable to install wheels and appurtenances to develop power up to that which will be produced by the minimum flow for the four months of highest water in the year; in other parts it is necessary to develop to the minimum for the highest eight or ten months in order to warrant the expenditure. The market for such power is the deciding factor. A fair average limit of profitable installation for the entire country is represented by the power corresponding to the minimum flow for the six highest months in the year; this factor has been used in the following schedule.

The third basis for power statement is the "total power with conservation," that is, the power which may be developed if the upland floods are stored in reservoirs and held until needed during dry seasons. It is plain that such a procedure will greatly increase the low-water flow and correspondingly increase the primary power available. Such a process is the highest development of a river for use in any capacity. The primary power so developed is the maximum that the river will furnish.

In developing the following figures consideration has been given to many of the conditions that prescribe the limits of power production on our rivers. Especially has the slope of the stream channels been scrutinized. The theoretical energy developed by a river is that which would be produced by the average amount of water that it carries if it should fall a perpendicular distance equal to the fall of the river from source to mouth. It has not been assumed that, even under ideal conditions of market, all theoretical power will ever be commercially available. The flatter portions of river channels can never be profitably developed and they have not been included in the schedule. In all cases the actually measured fall has been reduced ten per cent. in the computations. A further reduction of ten per cent. has been made to compensate for wheel efficiency. It is recognized that ninety per cent. is too high a wheel efficiency to be used in calculations of power at the present time, seventy-five or eighty per cent. being the usual installation maximum. Here again, it should be recalled that we are computing for future conditions as well as present ones and it may confidently be expected that, with the improvement of turbines, a greater percentage of the theoretical power will be realized on the shaft. We may expect before long to secure a ninety per cent. efficiency.

The rivers have been divided into sections of varying length, determined by channel slope, and the fall and flow of each section have been obtained from the best available sources of information. The records of stream flow collected by the Water Resources Branch of the Geological Survey have almost uniformly been the only available resort, although acknowledgments should be made to the State Water Supply Commissions of New York and Pennsylvania, the State Engineers of New York, Colorado, California, Oregon and Nebraska, the Territorial Engineer of New Mexico, the State Geological Surveys of Maine, New Jersey, North Carolina, Virginia, Georgia and Wisconsin, and to the various other bodies and individuals, public and private, who in the past have maintained measurements in co-operation with the United States Geological Survey, or independently. Use has also been made of certain river gauge records of the United States Weather Bureau and the Corps of Engineers, U. S. A.

In the actual management of storage the waters are released according as needed and they must be distributed as closely as possible according to the severity and length of the dry season. Such distribution will vary each year according to the climatological conditions governing river discharge. Some assumption has been necessary and it is believed, from the experience gained in the study of rivers throughout the country, that it will be fair and conservative to assume that if in present computations of the amount of power with conservation any given storage be considered as drawn upon uniformly during six months of the year and the natural flow from the unconserved areas be considered as sufficient to maintain at least an equal flow during the remaining six months, the results will not depart too widely from the actual conditions as regards total power.

The following schedule is the result of the process above outlined. The results do not include the State of Pennsylvania, figures for which had not been furnished up to the date of this report.

Principal Drainages.	Drainage area, sq. miles	Flow per annum, billion cubic ft.	Horse power available.	
			Primary or minimum.	Minimum of the six highest months.
Northern Atlantic to Cape Henry, Va.	159,879	8,942	1,702,000	3,186,600
Southern Atlantic to Cape Sable, Fla.	123,920	5,560	1,253,000	1,957,800
Eastern Gulf of Mexico to Mississippi River	142,220	6,867	559,000	963,000
Western Gulf of Mexico west of Vermilion River	433,700*	2,232*	433,760	822,650
Mississippi River, main stem	1,238,800	21,940	147,000	335,000
Mississippi River (tributaries from east)	333,600	12,360	2,472,590	4,940,300
Mississippi River (tributaries from west, including Vermilion River)	905,200	9,580	3,948,970	7,085,000
St. Lawrence River to Canadian line	299,720†	8,583†	6,682,480	8,090,060
Colorado River, above Yuma, Ariz.	225,000	521	2,918,500	5,546,000
Southern Pacific to Point Bonita, Cal.	70,700	2,193	3,215,400	7,808,300
Northern Pacific	290,400	15,220	12,979,700	24,701,000
Great Basin	223,000	.....	518,000	801,000
Hudson Bay	62,150	614	75,800	212,600
Total	4,508,289	94,612	36,906,200	66,449,310

*Includes Rio Grande in Mexico.
†Includes drainage in Canada.

The remarkable feature of the foregoing table is the indicated amount of available water power in the Northern Pacific drainage. This area includes all the Pacific Coast streams north of Point

Bonita or Golden Gate. It includes the Sacramento River and its highland tributaries, also the Columbia River. The latter is by far the greatest water-power stream on the American continent. Few people living within the basin have any adequate idea of the resources there, and the remainder of the people of the country are practically ignorant even of the general facts. In a country as great as that of the United States and in which water powers are so abundant, it is astonishing to find that one-third of the power resources are existent in this proportionately small area.

The drainage next in size from the standpoint of water power is that of the St. Lawrence. It is needless to state that the power resources at Niagara, which include the cataract and rapids below, add materially to the total figure. Although in the foregoing table the drainage area and the flow are given complete, the water-power figures, outside of Niagara and the St. Lawrence itself, include only those powers within the territory of the United States. The total power afforded by Niagara River will never be utilized unless at some time in the future there is a demand for mechanical energy that transcends other considerations. Steps have already been taken by the United States and similar action is promised by the Dominion Government, under which a restriction is placed on the production of power so that the scenic beauty of the falls will not be destroyed. However praiseworthy this policy may be, it will certainly give way if at any time in the future necessity demands that all the Niagara power be placed in productive use. Of course, the contingency is remote—let us hope that it may never materialize.

The other great areas in which enormous power is available are the eastern and western slopes of the Appalachian Mountains, the eastern slope of the Rocky Mountains and Colorado River basin.

An endeavor has been made to estimate the power that might be produced if all storage facilities that were practicably available were developed. Topographic surveys on many of the basins make it possible to give a fairly close estimate; but, inasmuch as three-fourths of the country has not been surveyed in this way, the estimates for that area must be approximate. There are two methods by which such an estimate can be made. In the first, it is necessary to determine the power with conservation in those portions of the country covered by adequate surveys, and then to assume that if the amount so secured represents one-fourth of our total area the total power must be approximately four times that amount. An examination of the facts will readily show that the amount so obtained will be too small. It is apparent from a review of the index map showing the areas covered by topographic surveys that a fairly large proportion, probably one-third, comprises country in which there are no feasible reservoir sites or in which they are uncommon in occurrence. Such portions include large parts of the Dakotas, Nebraska, Kansas, Oklahoma, Texas and Louisiana, together with great areas on the Atlantic and Pacific coastal plains. Therefore to increase the total available water power, from storage that may be computed on surveyed portions, by the ratio of total surveyed area to the area of the entire country would hardly do justice to the situation. Nevertheless, the figures are here presented.

It is found that the total power with conservation available in the surveyed portions is about 53,000,000 H. P. If this be considered as one-fourth, to correspond with the proportion of the country surveyed, the total power of the country, with practicable maximum storage, will be about 212,000,000 H. P.

The second method involves detailed study of the physiographic features of the country. The topographic surveys, while they cover only one-fourth of the total area of the country, have nevertheless been prosecuted in all sections and on all types of drainage area. If it is found, for example, that over a certain portion of the Colorado basin topographic surveys reveal a certain factor of storage, then it will be fair to assume that in every portion of that basin of the same physiographic type the same factor will roughly apply. This process has been employed for the whole country, and while the results are by no means sufficient for working estimates, they do nevertheless establish a fairly definite and reasonable limit. By using this method, there is afforded a grand total of 230,800,000 H. P. This figure agrees so closely with that obtained by the first method that both figures are worthy of some confidence.

In any case, it will be fair to assume that, when all practicable storage sites are utilized and the water is properly applied, there will be eventually developed in the country a total power equivalent to at least 200,000,000 H. P.

No one can fix the date at which our people will use all this power. There are involved too many uncertain factors, the potency of which is either totally unknown or can merely be approximated.

One who attempts to fix any precise or even approximate date will encounter the following difficulties.

First:—About eighty per cent. of the power used at the present time is produced from fuel. This percentage will decrease in the future, until the high cost of fuel will finally drive fuel power out of the market. Therefore, in summing up our future power utilization we may assume that all power now and hereafter generated from fuel may be disregarded, for it will all finally be displaced by water power. The current increase in the use of fuel power is enormous and must continue for several decades at least. The great water-power developments of the next quarter century will be designed to supply mechanical energy to new markets in regions and places now unsupplied rather than to take the place of steam plants already installed. No one expects to see in the near future any actual decrease in the amount of steam power utilized unless, perchance, by some happy combination of events there should be brought about in the minds of our people a realization of things as they ought to be. Few men, in this generation at least, are possessed of sufficient altruistic instincts to induce them to give up their steam plants for the sake of the ultimate conservation of our coal resources. But even if this were not so, there would still be enormous utilization of coal. There are great centers of power utilization which, under the present limits of electrical transmission and conversion, can not be served by water power because they are situated too far from water-power sites. Therefore fuel power is necessary and will be utilized until electrical transmission has been made more efficient. All of this brings a fluctuating factor into the prediction concerning the sufficiency of our water powers in future years. There is no escape from a broad generalization in this matter.

Second:—It is unsafe to estimate the future demand for power from past utilization. The increase in the amount of power used for manufacturing purposes during the decade 1870-1880 was forty-eight per cent. During the next decade it was seventy-four per cent. From 1890 to 1900 it was seventy-five per cent., while in the year 1910 the increase over that of 1900 promises to be about eighty-five per cent. There is an increasing rate of increase in the utilization of power at the present time, but this can not always continue. While it may be that the actual amount of power in use will increase with each decade and that each decade's actual increase will be greater than that of the preceding, the percentage increase must, after a while, be less each decade. Just what this rate of decrease will be can not be foretold, for it is dependent upon so many changes in methods and production that it, too, must be largely generalized.

Third:—By way of partial compensation for the growing demand upon our power resources, there is the assured increase in efficiency with which that power is used. This is merely another way of saying that we shall accomplish more in the future with one horse power than we can to-day. The losses of potential power between the falling water and the application of that power, after transmission, transformation, etc., to productive work are great, but not as great as they were in years past. This improvement will continue, but no one knows how fast, and therefore another uncertain element enters into any estimate of the sufficiency of our water power resources. If in the use of our 200,000,000 H. P. we reduce the losses in efficiency from forty per cent. to ten per cent., the effect will be the same as though 60,000,000 H. P. were added to our ultimate resources.

All we know to-day is that according to our best calculations we have of available water power in the United States somewhat more than seven times our present total power utilization. Considering the matter broadly, with the above fluctuating factors in view, as well as many others not here discussed, it seems safe to predict that our water power will be sufficient for our needs for at least seven generations hence.

The water-power plants in the United States make productive use of only five and one-half million horse powers, an amount which is less than one-fortieth of that ultimately available.

The following table contains a summary of the number of water-power wheels and the horse power generated in each of the states of the Union. The figures are the result of a census made during the year 1908 by the United States Census Bureau. It is probable that they are not complete; yet all the important plants are included and it is certain that the missing data form so small a proportion of the total that these results can be accepted as substantially correct.

State.	Wheels.	H. P.
New York	6,513	885,862
California	1,070	466,774
Maine	2,797	343,096
Pennsylvania	5,596	290,990
Massachusetts	2,749	260,182
Oregon	590	231,379
Wisconsin	1,667	220,916
South Carolina	1,301	207,242
Michigan	1,498	205,019
New Hampshire	1,709	183,167
Vermont	2,018	170,276
Georgia	2,314	166,587
North Carolina	3,975	162,284
Alabama	1,804	161,694
Minnesota	531	152,380
Montana	204	148,052
Washington	475	147,041
Connecticut	1,546	118,145
Virginia	3,011	100,123
Tennessee	2,160	95,060
Colorado	353	78,878
Idaho	285	78,743
Utah	260	64,265
Illinois	413	50,116
New Jersey	902	38,011
Rhode Island	387	37,165
Ohio	873	34,840
Indiana	495	29,153
Maryland	694	21,715
Nevada	39	20,577
West Virginia	672	20,500
Kansas	184	18,606
Iowa	461	17,304
Alaska	106	17,289
Arizona	37	16,855
Kentucky	834	14,156
Nebraska	227	12,792
South Dakota	68	11,112
Missouri	397	10,107
Texas	195	9,966
Delaware	277	7,976
Mississippi	336	7,922
Arkansas	255	5,868
Florida	207	4,539
Wyoming	66	3,855
Oklahoma	29	2,994

State.	Wheels.	H. P.
New Mexico	56	2,310
Louisiana	79	1,184
District of Columbia	6	1,000
North Dakota	16	613
Total	52,827	5,356,680

The above results are shown by general drainage divisions of the country as follows:

Division of the United States.	Wheels.	H. P.
Northern Atlantic	21,864	1,746,303
Southern Atlantic	5,938	459,652
Gulf of Mexico:		
Eastern	3,342	139,758
Western	258	12,071
Mississippi River:		
Tributaries from east	8,959	537,080
Tributaries from west	2,385	331,739
St. Lawrence River	6,896	1,018,283
Colorado River	285	74,428
Southern Pacific	822	423,707
Northern Pacific	1,659	489,454
Interior Drainage	353	115,944
Arctic Ocean	66	8,261
Total	52,827	5,356,680

Some interesting facts are shown by the above. The total development in the country is 5,356,680 H. P. over 52,827 wheels, or an average development per wheel of about 100 H. P. In the Northern Atlantic Division there has been a greater water-power development than in any other, the total installation being 1,746,303 H. P. The only other division that approaches the Northern Atlantic in development is that covering the drainage area of the St. Lawrence, including the Great Lakes, where there has been a development of 1,018,283 H. P.

The great power development in the Northern Atlantic Division began at an earlier period than in any other portion of the country. New England and the Middle Atlantic States are and have been the important manufacturing centers of the country, largely by reason of the impetus imparted early in our history by the abundance of good water powers. Comparisons of wheel capacities installed in various parts of the country are interesting. While the total figures show that the average power per wheel is about 100 H. P., the units in the various districts vary as follows:

Division.	Unit capacity H. P. per wheel.
Northern Atlantic	80
Southern Atlantic	77
Eastern Gulf of Mexico	42
Western Gulf of Mexico	47
Eastern Mississippi	60
Western Mississippi	139
St. Lawrence	148
Colorado River	261
Southern Pacific	515
Northern Pacific	295
Interior Drainage	328
Arctic Ocean	125

The large number and small capacity of wheels in the eastern part of the country as compared with the smaller number and larger capacity in the western portions, including especially the rivers draining from the Rocky Mountains and the Sierras, may be explained: First, by the fact that in the eastern and central portions of the country the power privileges are of smaller capacity; and second, by the fact that in the eastern portions of the country a large number of the powers were installed at an early date, when small units were common. More recent practice has involved the establishment of larger units, and, as the western installations are all recent, this practice, taken together with the existence of the larger power privileges, gives the result that might be expected from a general survey of the situation.

The first table shows that New York State has the largest water-power development, the total being 885,862 H. P. It is proper to add that the Niagara powers on the New York side assist largely in increasing this figure. The second state in water-power development is California, the total development being 466,774 H. P. over 1070 wheels, or a unit installation of about 436 H. P. Water-power development in California is comparatively recent. The third state is Maine, with 343,096 H. P. over 2797 wheels, or an average of about 123 H. P. per wheel.

Among the other interesting points is the fact that, although the Northern Pacific division can be made to furnish about one-third of the total minimum horse power of the country, there is at the present time a development of only 450,000 H. P., which indicates clearly that the most fertile field for power development remaining in the United States is this northwestern country.

Census returns show that, out of a total of 31,537 powers reported, 602 are of capacity of 1000 H. P. or more. Recent progress in water-power development has been marked by great installations. In former years the aggregate water-power utilized in the country was made up largely of small units which, while useful for local purposes and worthy of development, are not relatively important in the great question of power economics. The following summary gives the distribution of the powers of 1000 H. P. and greater capacity, and it shows clearly that what was formerly believed to be an uncommonly great installation must now be considered a comparatively small one.

CAPACITY DISTRIBUTION OF POWERS OF 1,000 H. P. AND MORE.

1,000 to 5,000	5,000 to 10,000	10,000 to 15,000	15,000 to 20,000	20,000 to 25,000	25,000 to 40,000	40,000 to 60,000	60,000 to 100,000	100,000 and over.	Total number of powers.
459	65	27	13	17	11	4	3	3	602

Brief descriptions of typical water-power plants, including statements relative to their organization, field of application, etc., will now be given. Obviously, it will be impossible to enter upon a detailed description of the structural and mechanical features of the various plants. This, in itself, would require more space than has been allotted to the present paper. The best that can be done is to outline the most noteworthy features, which typify the various situations under which power plants are developed and operated.

The water power available at any privilege depends principally upon two factors: First, the amount of fall or the hydrostatic head on the wheels; second, the amount of water that can be turned over the wheels. Water powers developed in the United States represent all sorts of combinations of fall and flow, the particular type depending on the natural conditions at the various sites. In the earlier powers in New England and New York, for example, the static head is usually low and to develop a great amount of power it is necessary to discharge a large volume of water upon properly designed wheels. In many of the more modern plants of the West, where only a small amount of water is available, there is a great fall. As a result we may have in one place a plant developing, say, 10,000 H. P. with a fall of anywhere from twenty to forty feet, and in another place a plant of the same capacity with a fall of 1000, 1500 or 2000 feet. It is obvious that in the one case the lack of fall is compensated by the great volume of water and in the other case the converse conditions prevail. So far as the usefulness of the energy is concerned, it makes no difference whether the power be developed by the one type of plant or the other, although of course there is a difference in the application of the water and in the type of the implements of power conversion. So far as actual energy is concerned, it makes no difference whether we develop a certain amount of power by allowing ten cubic feet of water per second to fall one foot or by allowing one cubic foot of water per second to fall ten feet. In the following descriptions of power plants, the different conditions outlined above will be illustrated.

St. Lawrence Power Company.[2]—This plant is of a type in which the head on the wheels is limited, but this deficiency is made up by the use of a large amount of water. It is one of the more recent large power installations in the eastern part of the United States and was at the time of its construction the largest in the United States, with the exception of that at Niagara. The flow of St. Lawrence River is more nearly uniform than that of any large river on the American continent. All of the Great Lakes act as storage reservoirs and their capacity and expanse are so great that the fluctuations of flow that are common to rivers not so regulated are minimized.

In the vicinity of Massena, New York, the St. Lawrence descends over the Long Sault Rapids, the total fall in a distance of eight miles being forty feet. About three miles south of the St. Lawrence, Grasse River runs nearly parallel thereto and enters the former a short distance below the foot of these Rapids. As the channel of Grasse River lies at this point about forty feet lower than that of the St. Lawrence at the head of Long Sault Rapids there are afforded unusually favorable natural conditions for the development of a power plant. All that is necessary for such development is the cutting of a canal of large capacity across the plateau from the head of Long Sault Rapids and dropping the water over wheels into Grasse River.

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[2] Abstracted from "Engineering News," Feb. 21, 1901.

The plans for this development as originally laid out, provide for a canal 16,200 feet long, 226½ feet wide at the water line, and 25 feet deep, laid on a grade that will provide a flow sufficient for the generation of 75,000 H. P. The first step in the construction provides for the utilization of only 35,000 H. P., the canal having been excavated more than half its final width. At the end of the canal a dam and power house of monolithic concrete has been constructed. It is one of the largest ever undertaken in this country. The dam is a heavy wall, 8 feet thick at the water level and 15 feet thick at the floor of the turbine chambers. These chambers are located on the back of the dam and are separated from each other by walls 6 feet thick, laid at right angles to the axis of the main dam. The chambers between these walls are thirty-two feet in width and each contains three double horizontal turbines mounted on a common shaft. Each shaft pierces the wall of the turbine chamber and enters the dynamo room and upon each is mounted a 5000 H. P. generator. Each single turbine has a normal capacity of 1000 H. P. when working at a minimum net head of thirty-two feet. The generators are alternating-current, rotating field machines, developing 5000 H. P., each at a potential of 22,000 volts.

At the time the plant was constructed there was little or no market for the power in the vicinity of Massena, and it was the expectation of the promoters of the company that the erection of a power so cheap and efficient at this place would attract the location of sufficient industries, such as pulp and paper, chemicals, etc., to return a profit on the investment. The plant is therefore one of many in the United States constructed in anticipation of market rather than by reason of a market already in existence.

Southern Power Company.[3]—The Southern Power Company, organized June 20, 1905, is a good example of a consolidation of water-power interests, which appears to be necessary for the economic development of water powers in many parts of the country. Quite apart from all questions relating to the much discussed problem of industrial consolidation, there is a physical element govern-

[3] Construction details abstracted from "Engineering Record," May 18, 1907.

ing the development and utilization of water powers which demands that a large number of powers within certain regions have a common interest. The Southern Power Company, for example, has its field operation in the Piedmont section of the Carolinas, in lower North Carolina and upper South Carolina. Within this section the aggregate available water power is large, but the several units making up that aggregate are comparatively small. The electrical transmission of power over long distances has changed the whole industrial aspect of the matter. Where formerly a water power was utilized at the site and industrial developments proceeded there to the full capacity of that particular power, there was little or no inducement to combine several sites. In other words, the sites were independent in operation. Now, the site of a water power is not likely to be its field of operation, but the power is distributed over a large area. In this large area there is a common demand for power. The market itself constitutes an administrative unit. The demand of the region is a demand in the aggregate and, moreover, it is a demand that must be supplied whether or not the power at any particular point is abundant or scanty. It is a well-known fact that a certain privilege may now produce abundant power, and again may not produce sufficient to meet the normal demands. If the industrial activity of any particular centre is dependent upon that power, it should be clear that the uncertainties of securing power that would arise if only one site were utilized would surely inhibit productive development at that place. When, however, we combine a number of sites on a number of drainage areas, power supply will be comparatively steady. If the power available at a certain site and at a particular time is not sufficient to meet a certain demand, then the available power at a combination of sites may be sufficient.

There is another important consideration: At one point a certain amount of power may be urgently required at a certain time, while at another point the urgent demand may be at a different time, so that in addition to a varying supply, there is a varying demand. This makes it necessary to join together many varying sources of power in order that the supply may be steady, whatever may be the local fluctuations therein. The principle is entirely similar to that in which a company or an individual having large cash assets and urgent calls for money distributes those assets in several banks, with the result that in time of financial depression if one bank suspends, there is, in another depository, a sufficient amount of call money to insure the continuance of the business. In other words, the demand for power and the utilization thereof are such that it is fatal to have all the eggs in one basket. This should not be considered as a plea for or a justification of indefinite power consolidation. That subject is not in the province of this paper. It should, on the contrary, be regarded merely as an expression of the requirements imposed by nature's laws.

The original field of the Southern Power Company included ten water-power sites in the basins of the Broad and Wateree Rivers, the aggregate horse power available being about 130,000, of which the largest unit, that at the Great Falls of the Catawba, has a capacity of 30,000 H. P. The other sites are: Rocky Creek, Catawba River, 20,000 H. P.; Fishing Creek, Catawba River, 15,000 H. P.; Catawba River at Catawba, 10,000 H. P.; Catawba River at Mountain Island, 5000 H. P.; Catawba River at Landsford, 12,000 H. P.; Catawba River at Horseford Shoals, 3000 H. P.; Catawba River at Lookout Shoals, 5000 H. P.; Wateree River, above Camden, S. C., 20,000 H. P., and Broad River at Ninety-nine Islands, 10,000 H. P. All of these powers are of comparatively low head. One of the typical ones, that at the Great Falls of the Catawba, will be described.

The Great Falls of the Catawba cover about eight miles of that river, the fall in that distance being 176 feet. The plan adopted by the Southern Power Company contemplates the utilization of the fall of three plants, which will utilize sixty, seventy-two and forty feet, respectively, the minimum flows at the three plants being 2220, 2100 and 1950 cubic feet per second, respectively. The resulting powers, allowing eighty per cent. efficiency on the wheels, are approximately 12,000, 14,000 and 7000, respectively. The arrangement of the middle development, or the one having the head of seventy-two feet, is as follows:

At the head of these falls the river channel is divided into two parts by Mountain Island. Across one of these channels at the head of the Island, an overflow diversion dam is erected which, in times of low water, deflects all of the flow into the other channel. The main dam at the headworks is located across this channel near the foot of Mountain Island and from thence the power canal conducts the water nearly one and one-half miles to the tail-race which is located near Rocky Creek, a tributary that enters the Catawba below the fall here immediately utilized. This arrangement was largely adjusted to conform with the natural grade lines there existing, the course of the canal being a natural valley, and a comparatively small amount of excavation was necessary. At the power station, the water is passed over eight wheels and two exciter turbines, through steel penstocks with suitable regulating works. The eight large turbines were required under the contract to furnish 5200 H. P. each, at 225 revolutions per minute under a head of seventy-two feet. The discharge from these turbines is conducted into the tail-race between piers supporting the power house.

The Animas Canal Reservoir Water Power Company.[4]—This plant is located in San Juan County, southern Colorado. It is typical of many throughout the country, and especially in the West, which are built in advance of a demand for full capacity of the power privilege. In such places, where a market must be created, it is the usual practice to develop only a part of the power available and to build certain of the appurtenant works of low-cost materials. Thus, the first cost of the plant is reduced to a point at which the small initial business may pay for the fixed charges and possibly return some dividends. In this way, the plant becomes self-supporting while the market grows. From time to time, the temporary structures are replaced by permanent ones and ultimately the full power of the privilege is developed.

The Animas plant is one of the type that utilizes a small amount of water over a high head, the power being recovered on impulse wheels. The water for the first installation was taken from Cascade Creek, a tributary of Animas River. From there it is conducted by a wooden flume about three-quarters of a mile to another tributary, across which is constructed a dam fifty-five feet high and 750 feet long. This dam is a temporary structure of stone and timber, which will one day be replaced by a masonry structure of nearly twice the present height. From this storage reservoir, the water is conducted by another wooden flume about one and one-quarter miles long to an intake basin, and from this the water is delivered through steel conduit upon Pelton wheels at a static head of about 1000 feet.

The amount of water required by the first installation is eighty-seven cubic feet per second and the power developed is from 6000 to 8000 H. P. Future additions to the water supply will provide for an ultimate development of 38,000 H. P.

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[4] Abstracted from "Engineering News," of Jan. 4, 1906.

The intake basin, steel conduit, and power-house appurtenances are permanent structures, as distinguished from all that portion of the works above the intake basin. The only change necessary in these lower works in case of increased capacity of plant will be additional installation of conduits, wheels, generators, etc.

The first installation consisted of two Pelton wheels, each of 3000 H. P. capacity under normal delivery, but so adjusted that they may be made to develop 4000 H. P. each. They are eight feet in diameter and normally operate at 300 revolutions per minute. The electrical equipment consists of two revolving field three-phase sixty-cycle alternators, each of 2250 kilowatts capacity. They afford a voltage of 4000, which current is transformed to 50,000 by six water-cooled oil transformers, each of 750 kilowatts capacity. The current is transmitted over three cables, each of which consists of six aluminum, No. 8 B. & S. wires with a hemp core. The power is transmitted twenty-five miles to Durango and Silverton.

The Snoqualmie Falls Water Power Plant, Washington State.[5] —This is a cataract power. Those heretofore described are of a type requiring construction of long canals or flumes. The Snoqualmie Falls power takes advantage of a vertical drop in the channel of that river amounting to about 270 feet. In this respect the privilege resembles that at Niagara. We are accustomed to consider that Niagara Falls develops the greatest cataract head in the country; yet the vertical drop there that has been utilized for power production is only 153 feet. The Snoqualmie plant is interesting in many respects.

The usual procedure in installing power plants on such cataracts is to divert the water by means of suitable conduits either in tunnel beneath the cliffs or down the outside thereof to the power house erected above ground at the foot of the cataract. In the present case the water is diverted by suitably arranged headworks into a conduit set in a vertical shaft that descends into the cliff a short distance above the crest of the falls. In other words, a hole is made in the bottom of the river at that point and the water is let down into a chamber excavated in the solid rock to the high water level of the pool below the falls. This shaft is ten by twenty-seven feet in cross-section area and 270 feet deep. Beginning at the foot of the shaft and extending horizontally, a chamber 200 feet in length, forty feet wide and thirty feet high was excavated. In this chamber the wheels and electrical apparatus are installed. The tail-race consists of a tunnel excavated below the floor of the machinery chamber twelve feet wide and twenty-four feet high and extending outward to the foot of the falls. Thus, the entire generating plant is concealed and the only evidence to the casual observer of the existence of such a plant is the structure at the headworks and the opening of the tail-race tunnel at the foot of the cliff. The conduit that conducts the water from the surface extends along the top of the machinery chamber and from it branches are taken leading to the wheels. This conduit or penstock is a steel pipe, seven and one-half feet in diameter. The branches leading therefrom to the wheels are fitted with gate valves weighing 23,000 pounds each and were at the time of installation the largest in the world.

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[5] **Abstracted from "Engineering News," Dec. 13, 1900.**

The generating plant consists of four electrical generators, each driven by a Doble water motor of 2500 H. P. capacity. This motor consists of a shaft carrying tangential jet wheels and the water is conducted under pressure against the flanges by two nozzles to each wheel, these nozzles being so placed that the two jets of water are delivered against the wheel flanges at right angles to each other. Each wheel unit weighs about 100,000 pounds. The electrical generators are of 1500 kilowatt capacity each. They are of the revolving armature type, delivering a three-phase current at 1000 volts, 7200 alternations. The transformer house is above ground at the head of the shaft. The current is received at an initial voltage of 1000 and is raised to 30,000. The power is transmitted to Seattle, Tacoma and Everett, at distances of thirty-two, forty-four and thirty-five miles, respectively. The transmission circuits are of stranded aluminum cables, and this was the first instance of the use of this metal in long-distance transmission. These wires stop at the city limits of Seattle, Tacoma and Everett, and copper is used beyond these points.

The ultimate capacity of the plant is about 100,000 H. P., and the flow of the river at its lowest stage is about 1000 cubic feet per second. In order to accomplish the ultimate power capacity, it will be necessary to construct reservoirs in the Cascade Range at the head of Snoqualmie River and sites for such reservoir systems are abundant. Construction on this plant was begun April 17, 1898, and it was put into operation on July 31, 1899.

Conclusion.—A few of the general principles governing water-power development have been reviewed. Some of the broader considerations relating to the political economy of the production and use of mechanical energy have been cited. There is much more that might be said. The main purpose of the paper has been to emphasize the fact that the water powers of this country have a higher ultimate significance than is generally conceded to them, and that they are certain to have a dominating effect upon the material progress and the integrity of this Republic. If we are to place ourselves in an economic position in which we may finally prevail as a world power, our point of view regarding fuel and water power must be changed, and our policies must be altered so that we may wisely prepare to use the vast power resources which we are now neglecting.

THE SCOPE OF STATE AND FEDERAL LEGISLATION CONCERNING THE USE OF WATERS

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One of the leading defects of the confederation of the American Colonies, after the accomplishment of independence, was the want of power in the congresses to regulate commerce, and this, as much as any single cause, "conduced to the establishment of the Constitution," as Mr. Justice Story says in his "Commentaries on the Constitution." The power "to regulate commerce," conferred on the Congress of the Federal Government by the eighth section of Article I of the Constitution embraces the exclusive control of navigation. (*Gibbons* v. *Ogden*, 9 Wheat. 1.) The organic source of federal authority in the control of waters is in this section; the limitation of its power is that farthermost bound which marks the beginning of things not well within operation of a regulation concerning commerce among the states or with a foreign nation or an Indian tribe.

All that absolute right to regulate commerce and navigation carried on within their waters, or to improve navigation on intraterritorial streams, as well as such power over non-navigable waters, as existed in the government of the mother country, passed to the several colonies upon the acknowledgment of their independence. Title to the water and to the subjacent soil belonged to these several states, subject to the local laws and usages governing riparian rights, and was not surrendered at the adoption of the Constitution. The Federal Government, for purposes of commerce, merely acquired a paramount right to control all waters, intra- or inter-state, capable of supporting navigation among these units of the Union. In theory, it has power to conserve the public usufruct in waters so far as navigation is concerned—its jurisdiction ceasing at this point. The mode of the exercise of this power is left to the Congress with no limitation beyond that suggested by the purpose of the grant—to regulate commerce. Congress has the right to improve navigation; it may do this by dredging or by the erection of dams with locks, or by either; or, it may do all things necessary to induce or regulate suitable stream flow through storage or headwaters, and it is believed, through the conservation of those reservoirs established by nature, the forests. Any and all methods which have the primary purpose of aiding or facilitating transportation by water are within the scope of federal legislative power.

While this power of quasi-sovereignty over navigable waters was transferred from the crown to the colonies, and afterward delegated by the latter to the National Government, the common law definition of a navigable watercourse, for a very obvious reason, was not a part of the acquisition. In the mother country, the ebb and flow of the tide constituted the determining factor, while here it is always a question of fact whether a stream be navigable or otherwise. Such great natural waterways, extending their courses hundreds of miles from the sea, like the Mississippi or the Ohio, were unknown in England; and to such conditions, the common law doctrine was plainly inapplicable.

Over those streams or bodies of water incapable of use for the purposes of trade or commerce in any way, the United States has no jurisdiction except in a single respect later to be mentioned. Of course, in those parts where the territorial form of government still exists, the Federal Government is both sovereign and proprietor as to such waters. It has the *jus publicum* and the *jus privatum.* Upon the admission of territories to statehood, this dual right is relinquished to the state subject to such prior grants as the Federal Government has made and generally upon the condition that the waters shall remain highways free to the citizens of the United States. The new states acquire the same rights, sovereignty and jurisdiction as were reserved to the thirteen original states at the adoption of the Constitution. (*Pollard* v. *Hagan,* 3 How. 212.) Generally speaking, then, each state has absolute sovereignty over non-navigable waters within its boundaries, as well as title to and dominion over navigable streams qualified only by the prerogatives surrendered to the Federal Government—the paramount control of the waters for navigation purposes. To the latter, all else must yield.

Aside from the adaptability of waters to the transportation of commerce, streams are mainly valuable as a source of power production and domestic water supply, and, in the arid regions, for irrigation purposes. The state, generally, has control of the use of water in these respects, so far as any *jus publicum* is concerned.

The eastern seaboard states inherited the common law rule of riparian rights. A grant of land bordering on a non-navigable watercourse carried ownership to the centre or thread of the stream, subject to the public easement. That is, the title to the river bed *ad filum aquae* is in the riparian proprietors, not in common, but in severalty. Each proprietor has an equal right to the *use* of the water which flows in the stream adjacent to his land, as it was wont to run, without diminution or alteration. He has no property in the water; only a mere usufruct as it passes. He may not detain it, or divert it to the prejudice of other proprietors, up stream or down, save in some cases where he has a prior right or title to some exclusive enjoyment. He may divert it or a part of it provided he returns it to its usual channel as it leaves his estate. But the maxim usually applicable is *"Aqua currit et debet currere ut currere solebat."*

Ownership of lands upon the borders of a navigable stream, at common law, involved another rule: the boundary of the grant was the high water mark. The rule, however, is not applied in all the states. In some states it is held that riparian proprietorship extends to low-water mark, while in many the rule is the same as to both navigable and non-navigable streams—ownership of the bed of the stream *ad filum aquae,* subject to the public easement in the waters. Where the riparian's line extends to high or low-water mark, title to the river bed is in the state. As to the water itself, the state, whose interest is that of a sovereign, holds the property in the stream as a trustee for the public, subject to the rights of the United States, if it be a navigable stream, and to the rights of the riparian proprietor. The rights of the latter, however, must yield to the exercise of the police power of the state when the public welfare and health are in jeopardy. Aside from navigation, then, the state and the owners of the land by which it passes are the only parties which have an interest in such waters. Disputes between riparians are settled in the state courts. Needful regulations concerning pollution, etc., are within the scope of the legislative powers of the state, as are also mill acts, the maintenance of ferries, the erection of bridges, etc. It is even competent for a state, in the absence of adverse action by the Federal Government, to improve navigation in those streams which are clearly, in that respect, within the federal jurisdiction. Likewise, and under such conditions, prior to federal legislation on the subject, the state could authorize the construction of dams or bridges. Of course when either interfered with navigation, the United States could order the removal of obstructions; and this without compensation. Under existing acts of Congress, however, dams, and other structures which may menace navigation, may not be erected in a navigable stream, even if it be wholly intra-state, unless the location and plans thereof be approved by the Secretary of War and the Chief of Engineers of the Army. That is, while the state still may authorize such a construction, the authorization is ineffective until the location and plans are approved in the manner stated; and by the Act of June 21, 1906 *(34 Stat. 386)*, these officers, in approving the plans and location of a dam, the construction of which is authorized by Congress, possess the power to impose such conditions and stipulations as they may deem necessary to protect the present and future interests of the United States.

In some of the western states, the ancient riparian doctrine yields to the rule of prior appropriation for mining and irrigation. The requirements of mining invoked this rule, which is rather of a "first come, first served" nature. For mining purposes, it is necessary to divert water from the natural course of its flow some distance to the mineral *in situ*. The first appropriator has the better right, and so on. The protection of these rights gave rise to numerous regulations and customs, which have been recognized by the state courts. Similar conditions in the arid regions induced the abandonment of the riparian doctrine—although in some of the states there is a mixed application of the old and new rule.

The adjustment of all these rights is the subject of state control. The Federal Government is a bystander unless interference with navigation is threatened or unless, as it may be, it is a riparian proprietor or appropriator itself; in which latter event its interest is merely that of any private owner.

Conflicting water rights are fruitful sources of local litigation; flowage, diversion, nuisances, etc. Here, the state, through its courts, is the adjuster. Through its legislature, it may regulate just so far as regulation does not involve the abrogation of vested rights. The public interest is fundamental and the "private property of riparian proprietors cannot be supposed to have deeper roots." (*Hudson Water Co.* v. *McCarter,* 209 U. S. 349.) Nevertheless, private ownership is often the stumbling block in the way of legislation that would promote the interests of the people as a whole, because the line where the state's police power, exercised without compensation, properly ends, and where its exercise of eminent domain, with compensation, must begin, is not always perspicuous. The circumstance of owning land bounded by a stream gives the owner an advantage—a right—in that which should be the property of all alike, and which in some states is declared to be the property of the state; as, for instance, in the Constitution of Wyoming:

> The water of all natural streams, springs, lakes or other collections of still water, within the boundaries of the state, are [*sic*] hereby declared to be the property of the state.

The Constitutions of Colorado and North Dakota contain similar provisions, and the Constitutions of California and Washington declare the use of waters for irrigation, mining and manufacturing purposes to be a public use; but this is one of the very few subjects not covered by the Constitution of Oklahoma.

Yet even where declared to be "the property of the state," the appropriator of the water acquires a distinct title; not perhaps as a mere incident to the soil, as in the case of a riparian owner, but still a distinct usufructuary estate based upon the actual appropriation; a property right which may not be taken or damaged for public or private use without just compensation.

The same basic principle exists in the Australian Commonwealth of Victoria; but there it is carried out to its legitimate conclusion. No one may permanently divert water; a license is granted for a limited period. And no diversion is free. Every user pays for what he uses, the charges being apportioned to the amount diverted and the value of the diversion to the user. For the development of hydro-electric power, for instance, the annual charge is about five dollars per H. P. A large revenue is thus produced, relieving the general taxpayer. The justice of this plan is apparent; he who enjoys pays therefor, and he who has an equal right in the water but cannot use it, is indirectly the beneficiary of the rental paid by the user; for general taxation is reduced. Moreover, the user has an economic reason for avoiding waste; he must pay for what he diverts. Every user is a conservator. During the last decade there has not been a single lawsuit over water rights in Victoria. Furthermore, the Commonwealth reserves the right at any time to apply the water to a paramount use whenever the necessity arises. Naturally there are no "vested rights" to figure largely in the matter of compensation. There is no such thing as a riparian right in this progressive British colony. On substantially all streams a frontage of from four to eight rods is reserved as public land. This solves the pollution problem and in other ways simplifies the conservation of the public's rights in the water.

As far as the rights of the American public in the free navigation of its streams are concerned, they are happily conserved because they are paramount and supersede any right in the private owner of the adjacent banks. But the country is now at the threshold of a wonderful development of its unused water power to be transmuted into electrical energy at the mill site, and thence transmitted hundreds of miles to a hundred uses: power, traction, lighting, heating, and the multifarious modes of employing this convenient form of energy. With this possibility of conversion and conduction, there is, at strategic points throughout the country, potential water power sufficient to replace every other form of power now in use in manufactures, transportation, and domestic economics. Of this, but a small fraction is now utilized—about 5,300,000 H. P. Some 1,400,000 H. P. runs to waste over government dams. Far-sighted captains of industry, realizing what the next generation will bring forth—reduction in the fuel supply with its complement, an enhancement of cost—and anticipating the advancement that will come in the art of utilizing hydro-electric power, have already seized advantageous points, and even now a small group of "interests" controls a third of the present water-power production; that is, produces power the equivalent of that proportionate part.

With this portentous concentration of power production, the states, in part, must contend. In those states where, in the substantive law the waters are the property of the "state" or the "people," the problem may be more easily solved than in those older commonwealths where the mill sites are in individual ownership—if the interests of the public are to be conserved. This, and preceding generations, have realized the significance of monopoly in those things which are vital factors in the lives of all consumers, whether it be heat, light, food products, or transportation. Yet all these united must be multiplied to be tantamount in power to the monopolistic Colossus which is yet but a suckling, nurturing itself at the breast of its foster-parent, the public. For heat, light and transportation, and the power that turns the spindles and grinds the corn, will be the product of transmuted water power within the lifetime of our children.

While the state should promote the development of its resources and encourage enterprise in the individual, the superior right of all the citizens should be guarded by such stipulations and conditions in every grant of franchise as will prevent consolidation of control in a few and anything like perpetuity in enjoyment of this privilege. The life of a franchise should be limited in all cases, to a fixed term of years, say forty or fifty years, irrevocable save for breach of conditions, unless the state must take the water for a higher use in which event compensation must be paid. As the grant of a franchise proceeds from the many to a few who thus acquire special interests in the common property, the many should be recompensed by the payment of annual charges and by a limitation upon the price at which power may be sold.

While these things fall mainly within the scope of the state's power to legislate, the field of federal authority is much greater than its mere interest in navigation would suggest. Aside from the fact that in improving navigation on certain water courses, it develops incidentally a vast water power, it also has control of the location and construction of all dams across navigable streams, whether interstate or intrastate. Nor is this all; as the owner of lands bordering on a stream, it has all the rights of a riparian proprietor in those states where such rights are recognized; and, in its duty to conserve navigability of waterways, its jurisdiction is not necessarily limited to the navigable portions thereof, but may extend to the headwaters and those tributaries which supply or augment its flow. That is, if the diversion or appropriation to any inferior private or even public use of the waters of a tributary impairs or menaces the navigation of the main stream, Congress has power to check or regulate or prevent such use. No state may so legislate as to the appropriation of waters within its boundaries, even of non-navigable tributaries which unite into a navigable water course, so as to destroy or interfere with the navigability of that water course in derogation of the interests of all the people of the United States. This was settled by the Supreme Court in *United States* v. *Rio Grande Dam & Irrigation Co.* (174 U. S. 690).

A notable instance of the exercise of the federal power is found in the creation of the California Debris Commission (*27 Stat. 507*), in 1893. The navigation of two rivers, each within the State of California, the Sacramento and the San Joaquin, was threatened, in part, practically destroyed by hydraulic mining operations carried on in the territory drained by their tributaries. Congress declared such mining to be unlawful, unless the persons desirous of engaging therein obtained a permit from the Debris Commission, and assented to be bound by federal law and regulation. The Commission had full power to prescribe rules, to locate debris reservoirs, impounding dams, storage sites in the tributaries, either for debris or for water, and to do all things needful to restore and maintain the navigability of said rivers, to deepen their channels, and even to protect their banks. These operations mainly affected the feeding streams, but the power of Congress nevertheless existed and was upheld by the Circuit Court of Appeals in *North Bloomfield Gravel Mining Co.* v. *United States* (99 Fed. Rep. 664). These were operations not necessarily in a stream, but by a stream, whereby silt and other debris were carried by the tributaries into the navigable rivers and therein deposited. The act not only affected those who contemplated the establishment of such mining, but also the owners of then existing impounding works. The court said:

> "Congress has the power and authority to control commerce and navigation on the navigable portion of the Sacramento and San Joaquin Rivers *and their tributaries,* and to prevent any obstruction on such streams, or the performance of any act, by any person or persons which would tend in any manner to interfere with interstate or foreign commerce."

While the Federal Government is not authorized by the Constitution to create a water power for commercial purposes, although it undoubtedly has a right to do so for its own purposes, it is inevitable that in improving inland streams by a series of dams and locks that water power will thus be created. Indeed, nearly 1,400,000 H. P. is now running to waste over government dams, constructed with no other view than that of aiding navigation. The government may not own the water, but it certainly owns the *power* it thus creates. Water power is not water; it is energy produced by the combination of running water and a suitable fall. Conceding that the *corpus*, the water itself even in a navigable stream, is the property of the state through which it passes, and that the Federal Government has no title to it, still it does enjoy the use and supreme control of it under its power to regulate commerce. In the use of it for a constitutional purpose, it may bring into existence that which was not there before—a form of energy. It owns what it produces and it may sell or lease the right to utilize its creature; and it would certainly be anomalous if it could not exact a consideration and impose a condition in making a sale or a lease. A sale is out of the question, for that would involve an investiture of rights which might later embarrass the government in the discharge of its duty respecting navigation. But the disposition and utilization of this power by the grant of a leasehold interest is not only a lawful, but a business-like exercise of federal power. Leases imply a termination of the lessee's interest at a definite time as well as a charge regularly to be paid. Just as I may impose conditions on my lessee restricting his use of my property or confining it in legitimate channels, so may the government restrict its grant in a manner to avoid monopoly. The charge it may impose may be devoted to general governmental purposes to the relief of taxation or be expended in the further development of navigation.

So, again, where the government by storage reservoirs, artificial or natural, expends money to conserve the flow of streams, it creates a condition of value in the production of power. By a natural storage reservoir about the headwaters of a stream, I mean a forest. Where the government has reserved a great forest for national purposes, expending money in its protection and the reforestation of its desolated areas, it is contributing as effectually to the perpetuity and uninterrupted development of power in a water course whose sources are protected by these national forests, as it would by the providence of artificial storage. The rivulets and creeks which spring from these forests unite to make in whole or part the navigable watercourse. A corporation is granted the right by the state legislature or by Congress to erect a dam on such a stream for the purpose of developing hydro-electric power. Under the federal law, it may not proceed until the Secretary of War and the Chief of Engineers approve not only the location, but the plans. Under the Act of June 21, 1906, already noticed, these federal officers are authorized to impose such conditions and stipulations as they may deem "necessary to protect the present and future interests of the United States." This power may include the condition that suitable locks to conserve the navigability of the stream shall be constructed and maintained by the licensee. But "conditions and stipulations" need not and should not stop here. Not only should a definite term for the enjoyment of the privilege be fixed, but an annual charge should be exacted, apportioned, as in Australia, to the horse-power production or, better yet, on the basis of the converted power reckoned in kilowatt hours. Why not? A special privilege in what all the public possess rights is enjoyed by the beneficiary. The public indirectly contribute of their money to maintain the permanence and relative regularity of the stream-flow, on which power in part depends, through its maintenance and care of those great natural conservators of moisture, the forests. The effect may be great or slight, proximate or remote. But it is there —a tangible asset of measurable value to the producer of power. In proportion to its value, the charge is capable of adjustment.

Aside from this, another reason for an annual charge is suggested by the existence of the lock; and in a navigable stream blocked by a dam, a lock is a necessary part of the structure. In the discharge of its duty to regulate commerce, the government should not delegate its obligation to operate such a lock to the power producer. Congress representing the public and using its money must provide an operator to tend the lock and to expedite the transportation of commerce. The lock is there because the dam is there; the dam is there that an individual, a person or a corporation, may enjoy certain privileges in what, of right, belongs to the public. Should the public pay the cost of operating an artificial device for the passage of commerce-laden vessels, occasioned by the obstruction of a natural course for the special benefit of one? Should I pay the expense of a gatekeeper required by my gratuitous grant of a right of way to another across my premises? The charge is not only legitimate and within the power of Congress to impose, but it is right and proper that he who enjoys the public's property should render recompense exactly as he would to the private owner.

Where the Federal Government creates the power in whole or in part, there is little opposition to the imposition of charges. Despite the attitude of a recent Congress in passing an act conferring special privileges upon an individual in a certain navigable waterway in the West, without any provision as to the payment of an annual charge, after the President, in vetoing a similar measure, had announced that he would sign no bill that did not thus provide; the same Congress later conceded the point in a case where the development of the power itself is the direct result of the government's operation. The recent Act of March 3, 1909 (*Public, No. 317*), provides in part that the right to the flow of water, and riparian water power and other rights now or hereafter owned by the United States in the Saint Mary's river, Michigan, "shall be forever conserved for the benefit of the Government of the United States, primarily for the purposes of navigation and *incidentally for the purpose of having the water power developed,* either for the direct use of the United States, or by lease or other agreement, through the Secretary of War . . . *Provided,* That a just and reasonable compensation shall be paid for the use of all waters or water power now or hereafter owned," etc. The act limits the term of the lease to thirty years and provides for the readjustment of compensation at periods of ten years, and again, doubly to assure, states that no such rights shall be granted "without just and adequate compensation."

The act expresses what I urge is well within the constitutional field of federal legislation: the right to dispose by lease of a water power created by the United States in the course of operations having the primary purpose of improving or conserving navigation. The language is a little startling in its ingenuous avowal that a part of the purpose, although incidental, is "having the water power developed." The Congress has no authority deliberately to create a water power for the purpose of disposing of it by lease; but if in the discharge of its duty to aid navigation, it unavoidably brings into existence such a power, it has the right of any private owner in disposing of its property, subject always to the superior right of the public in the free navigation of the stream. The Congress may not *purposely* develop a water power save for national needs; but it may purposely do things in aid of navigation which it well knows will incidentally result in the creation of such a power.

It may not build a storage reservoir for the purpose of maintaining the stability of water power; but it may do so under the guise of regulating commerce. It may not acquire from private owners a great forest about the headwaters of a stream for the purpose of conserving stream flow in aid of power development; but it has plenary authority so to act if the avowed purpose and certain effect are to assist navigation. Many peculiar things are done in the name of liberty; a few have been done in the name of the Constitution.

But there is another and a larger class of improvements; a class including water power developed in a navigable stream, under a federal or local franchise, with the consent of the Federal Government. Under the law already noticed, the owner of the franchise may not build his dam until the Secretary of War and the Chief of Engineers have approved the location as well as the plans; and in the act of approval they may impose conditions and stipulations "necessary to protect the present and future interests of the United States," where the authority to build the dam proceeds from Congress. In these instances, the Government does not build the dam or create the power. Perhaps it has done naught in aid of navigation on that stream. The water, in theory, is the property of the state and not of the nation. The fall is provided by nature and by the work of man—the individual rather than the public. The two elements which make the power are there without the aid of the Federal Government; the latter owns nothing—merely owes a duty. How, then, can it impose a charge? Yet President Roosevelt, in two sturdily patriotic messages vetoing bills granting such franchises, declared that he would sign no bill unless the same provided, among other things, that "There should be a license fee or charge which, though small or nominal at the outset, can in the future be adjusted so as to secure a control in the interest of the public."

In certain quarters, it is denied that the United States has power to impose a charge in such a case. It is argued that the charge would be either a direct tax or in the nature of an impost or excise tax. If the former, it must be apportioned among the states rather than levied directly by the Federal Government itself; if the latter, it must be uniformly levied on every dam and water power in the entire country.

The latter objection, however, is not altogether sound. Uniformity, in the sense of the constitutional provision respecting taxation, means a geographical uniformity, the tax operating on all similar properties. That is, in every instance where the Federal Government approves the location and plans of a dam, thereby authorizing its construction, whether in a navigable waterway east, west, north or south, the tax must be uniformly laid. But a water power developed on a non-navigable stream, without let or license from the National Government, would stand in another category. Any rule of conformity would not necessarily involve the inclusion of such dams or water power privileges; it would merely require the levy of such a tax upon every power privilege similarly authorized or confirmed by the Federal Government.

Recurring to the act of Congress establishing the California Debris Commission, already noticed in part, we find provisions for a "tax" which applies with no "geographical uniformity" throughout the country, but is restricted in operation to only a part of the State of California.

Briefly: The hydraulic process in mining may not be employed about the tributaries of certain navigable streams in that state without permit from the commission, the permit to be granted upon petition and hearing. The license, if granted by a majority of the board, embodies directions and specifications in detail as to the manner in which operations may proceed; what restraining or impounding works shall be built and maintained, and where they shall be located; "and in general set forth such further requirements and safeguards as will protect the public interests and prevent injury to the said navigable rivers, and the lands adjacent thereto, with such further conditions and limitations as will observe all the provisions of this act in relation to the working thereof *and the payment of taxes on the gross proceeds of the same. Provided,* That all expense incurred in complying with said order shall be borne by the owner or owners of such mine or mines." (*Act of March 1, 1893, Sec. 13.*) The "taxes on the gross proceeds" are imposed by the twenty-third section of the act, which provides that the operators of the mines affected by the act "shall pay a tax of three per centum on the gross proceeds" of the mine so worked, said "tax" to be ascertained and paid in accordance with regulations to be adopted by the Secretary of the Treasury and to be paid into the Federal treasury to the credit of the "Debris Fund," which shall be expended by said commission under the supervision of the Chief of Engineers and direction of the Secretary of War in the construction and maintenance of restraining works and settling reservoirs in aid of the purpose Congress had in mind in passing the act.

This act had been held to be constitutional, as already noted. Yet in terms it provides for the collection of a "tax" which is neither "apportioned" among the states nor is levied by any rule of uniformity. Rather than a general excise law, it is one of special and circumscribed application. Still, the charge imposed is christened a "tax." If it were a tax, there can be little doubt of the unconstitutionality of the act. Wherein does such a "tax" differ from that to be charged upon the grant of special privileges for power purposes in a navigable stream? Both find their reason for existence in the conservation of navigation, although the miners may be required to pay for privileges connected directly with non-navigable intra-state tributaries, while the power producers operate directly in the navigable stream itself.

But the charge is not a "tax" in the constitutional sense; it is of the nature of a license—the according of a special right or privilege to do a thing, which, without permission, would be unlawful. It is leave and liberty enjoyed as a matter of indulgence at the will of the Federal Government. For, if the latter were to withhold permission, the dam might not be erected. And, in this connection, it may now be noted that there is no power to compel the Secretary of War and the Chief of Engineers to approve any location or plan. The writ of mandamus would not lie to compel approval, for the function of these officers is not ministerial, but entirely discretionary. Congress placed no limitation upon their power to impose conditions and stipulations as to dams it authorizes, except that the aim must be to protect the present and future interests of the United States; the officers to be judges of the necessity and wisdom of the terms.

The power to charge for a special privilege is not necessarily an exercise of the power to tax. It is rather the right to exact a *quid pro quo*. Public interests are bound to be jeopardized, even though certain advantages to a locality accrue from the establishment of the power plant. One has already been suggested—the operation of a lock; for the very fact that gives the Federal Government any measure of control—viz., the navigability of the stream—involves the conservation of navigation through artificial means. The charge imposed liquidates this that otherwise would be a burden in the nature of a tax upon the public. Aside from this, another potential element of cost to the public is involved—the possibility that the Government may be obliged to remove the obstruction caused by the building of the dam at its own cost. Ordinarily this has been guarded against by the exaction of a bond in a large penal sum, the burden of carrying which is an annual charge upon the owners of the franchise. What vital objection can there be to the adoption of a plan whereby the licensee, in lieu of annual tribute to a bonding company, pays such premiums into the federal treasury—a measure of insurance against the loss that might be occasioned were the franchise holder bankrupt and the needs of navigation were to require the removal of the dam? The fund created by the payment of these charges may be either devoted directly to the betterment of navigation, particularly in the removal of obstructions, or turned into the Treasury as a part of the general fund, indirectly serving the same purpose by relieving the taxpayer. If the Federal Government has the power to withhold approval, it has power to bestow approval upon such terms as it may deem necessary to impose in order to protect the present or future interests of the United States. If it has the power to exact a bond to protect the public against loss when, in the interest of navigation, it becomes necessary to remove the obstruction, it has the power to create a fund for the same purpose. If the public in general contribute to that fund, their contributions are in the nature of a tax. If, however, the special beneficiaries of the granted permission contribute to establish such a fund, it is not a tax, but a license charge, the sole similarity being that both are a rendering to Cæsar of the things that are Cæsar's.

Moreover, it is entirely competent for Congress to insist that no privileges affecting navigable streams shall be granted to any corporation unless said corporation operates under a federal charter. The United States has authority to create a corporation as a means of carrying into effect any of its sovereign powers. (*McCulloch* v. *Maryland*, 4 Wheat. 316, 411.) Such a corporation may be authorized to construct a dam and lock in aid of navigation, and the incidentally developed power may be disposed of by the creature as well as by the sovereign itself—under such terms and conditions as

Congress sees fit to impose. This would bring every power company using the navigable waters of the nation directly under the visitorial control of a federal commission, the Interstate Commerce Commission, for instance, with power to regulate charges and to prevent the formation of unlawful or monopolistic combinations. It is only natural that such companies should receive their corporate animation from the power which controls and regulates interstate commerce, because the ulterior purpose of their being, thus created, would be the production and transmission of power, in itself a feature of commerce which, in its development and utilization, will acknowledge no state bounds. In the incorporation of such companies, coupled with the grant of these privileges in the waterways of the nation, the imposition of charges, the tribute that the creature pays to its creator, will follow easily, logically, and lawfully.

In conclusion: With non-navigable streams, three parties are concerned, (1) the riparian, or appropriator, who has a peculiar property interest therein, and (2) the state, which may have certain police duties to perform in the conservation of public welfare, and (3) the Federal Government, whose interest is strictly confined to such streams as are tributaries of a navigable watercourse and then only when the navigability of the latter is threatened. With the single exception just noted, the state has exclusive jurisdiction in the realm of legislative activities affecting such streams.

With navigable streams, the same parties are concerned, but in reverse order: (1) the United States, with the paramount duty of improving and maintaining navigation, preserving a superior use in the water, but without ownership thereof or of the subjacent or adjacent soil except in the occasional instance of riparian proprietorship; (2), the state, whose interest is a derivative of its sovereignty, holding its property therein as trustee for all public uses save navigation, subrogated to the superior rights of the Federal Government and of such rights as the riparian owner or appropriator may possess; and (3) the riparian owner or appropriator himself. The National Government has legislative control of all matters affecting navigation primarily and, to the extent already discussed, of the power development incidentally, when the latter affects the former; and in theory it is not easy to divorce the twain. All else is within the scope of state legislation.

The federal power proceeds from its obligation to regulate commerce, of which navigation is but a part. The prospective power development through hydro-electric agencies will be the solution of many existing problems involving the transportation of interstate commerce. The fundamental physical power, to be changed into an easily transmissible form of energy, will, in the future, be found in the greater waterways of the country—the navigable streams. The requirements of navigation and power development must be nicely adjusted; the latter not to interfere with the former; the former not to prevent the latter. The state may not oust the jurisdiction of the Federal Government in the regulation of the former. If the latter is exclusively a matter of state regulation, there will be conflict in adjustment. The public welfare of the whole nation is involved; not that of one state. Any uniform rule in the grant of power franchises which will abort monopoly by restricting the term of the grant to a definite time coupled with the exaction of a charge adjustable occasionally as the country's welfare may demand, and with a provision for revocation in the event of any attempted combination of interests which would effect a restraint of trade, must, and I believe constitutionally can, find its origin in an act of Congress.

THE NECESSITY FOR STATE OR FEDERAL REGULATION OF WATER POWER DEVELOPMENT

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A century and a quarter ago, a law was passed in the State of Vermont fixing the rates of toll that might be charged by owners of water-power grist mills for grinding grain. The law which thus regulated the conduct of a private business was enacted while Vermont was an independent self-governing commonwealth, before its entrance into the Union; and it remained on the statute books until a few years ago. The conditions of society and of industry when the law was enacted were in sharp contrast to those of the present day; yet the conditions which caused the passage of the law were not dissimilar to those on which legislation of a similar sort is to-day based.

The settlers in those thinly-populated pioneer communities were dependent on the grist mill to convert the grain their fields produced into usable form. But grist mills were very few and far between, and roads were often mere rough trails through the forest. The owner of one of these pioneer grist mills who took advantage of the settlers' necessity, to charge "what the traffic would bear," represented the public utility monopoly of that day.

It was to meet the extortion practiced by such eighteenth-century monopolies, doubtless, that the Vermont law was passed. It is noteworthy, however, that after this law had been on the statute books for more than a generation, an amendment was passed exempting grist mills operated by steam power. Apparently it was recognized that the public had an inherent right to regulate industries carried on by the use of water power. It is true that the English law of riparian rights was in force, and that the owner of a "mill privilege," as it was called, held title to it as to any other piece of real estate. Nevertheless, there seems to have been appreciation of the fact that water power was a gift of nature to the whole race, and that even though one held title to such a gift, he was subject in its use to legal regulation.

The conditions which brought about this early case of legal regulation of water-power plants soon passed away. The development of the steam engine put water power for many years in the background. It became much cheaper to develop steam power on the site where it was needed, than to locate the factory beside the waterfall. But in the late '80's, the application of electricity to industrial uses worked a revolution in the use of power. The electric light, the electric railway and the electro-chemical processes created new demands for power in enormous quantities. Coincidently came electric power transmission, making it possible to develop power at the waterfall and utilize it at the mine, the mill or the electric distributing station, distant a dozen or fifty or a hundred or more miles away.

An enormous impetus was thereby given to the use of water power, and, at the same time, modern engineering came in to revolutionize the machinery and the methods by which flowing streams are harnessed to the service of man. The millwright of a century or even a half century ago knew no other method of water-power development than the mill dam in the river bed and the wheel or turbine beside it. Where the natural fall of the stream was located, there the power had to be utilized. Thus the owner of the land around a natural waterfall owned all that was necessary in order to utilize the fall for power.

But modern methods of dam construction and conduit construction have revolutionized this condition. Water may be taken from a stream to-day, led in artificial channels for miles away from its natural course, stored in artificial lakes, used for power development at some site remote from any stream and finally discharged, perhaps, in a different watershed from that in which it originally flowed. Thus in the development of the water power of a river to-day on a broad and comprehensive scale, the old law of riparian rights, which gives to each owner of the land on a river's banks a right to the fall that occurs in flowing past his land, is often a hindrance to the largest and most economical commercial development.

And there is a still more potent reason for this. That reason is the enormous influence of water storage upon water power. The old time water-power plant had its capacity fixed by the flow of the stream in dry weather. The torrents that flowed past in the flood season were of no use, but on the contrary a source of great danger and frequent destruction. The only storage of the old-time mill was the little "mill-pond" above its own dam.

The variation in volume between a river at flood and at lowest water is enormous. In the arid regions of the far West, many streams, which are of large size when rain falls, become entirely dry at times. Even in the humid sections of the East, rivers vary enormously in their stage. The New York State Water Supply Commission in its fourth annual report, dated February 1, 1908, shows that the Hudson River, flowing out of the well-watered Adirondack region, with many lakes at its sources, has recorded a variation of 100 to 1 between the greatest and least flow at Mechanicville, or from 70,000 cubic feet per second in the flood of 1869 to 700 feet per second in the drought of 1908. Taking the average monthly discharge, the greatest was 30,900 cubic feet and the least was 1600 cubic feet. The same authority shows the variation of the flow of the Delaware River to be in the ratio of 375 to 1. The maximum flow at Port Jervis is 150,000 cubic feet per second. The least flow at the same point is 400 cubic feet per second.

Now, in the modern development of water-power plants what the engineer first looks to is the low-water flow and the extent to which this can be supplemented by storage. In the smaller streams it has often been possible by private enterprise to create storage basins and closely regulate the flow of the stream. There are rivers in the manufacturing districts of Massachusetts and Rhode Island whose flow has been almost completely equalized by storage, and whose available water power has been thereby multiplied many fold.

And this brings us to another great contrast between the old-time water-power development and that of the present day. Up to very recent times water-power development was confined almost wholly to small streams, many of them mere brooks. There was no demand for power to justify the use of large streams and no means for harnessing them had the demand existed. But to-day the largest rivers are being set to work. Power is developed by giant wheels generating ten thousand or more horse power on a single shaft. Cataracts and rapids which were supposed a generation ago to be beyond the power of man to control have been subdued. All along the Atlantic coast from Maine to Alabama, the largest rivers have been set at work turning spindles, lighting cities and drawing railway cars. Niagara itself has been set to work and nearly half a million useful horse power are being produced by water drawn from the upper river, yet the diminution of flow over the precipice is too small to be perceptible.

The amount of power available on these great rivers can be multiplied many fold by storage; but the creation of that storage can be accomplished only through legislation of a broad and radical sort, and legislation which can only be justified with public interests and not private interests as the beneficiary.

Attention may also be directed to the relation between the use of water for power and its use for other public purposes. The water flowing in the nation's streams and rivers to-day is used not only for power development, but for the supply of towns and cities, for irrigation and for navigation. Further than this the great problem of river control, of protection from devastating floods and of the drainage of great areas of fertile swamp lands is intimately connected with the matter of water-power development. All these public uses of our streams and rivers were almost unknown when the existing law of riparian rights was developed in the narrow island of Great Britain; and, until recent years, there has been no serious conflict between these various interests. The streams on which water powers were developed, for example, were too small for navigation. The amount of water required for city supply was so small that the extinguishment of the rights of water-power owners was no serious matter.

These conditions exist no longer. Cities which seek to increase their water supply find themselves compelled to pay millions of dollars in damages for water-power plants and even for water powers unused and undeveloped. A free gift of nature—the potential power in a falling stream at a certain point—is held to be private property which must be appraised and paid for by the public before it has the right to interfere with it, even when the private owner has made no use of this gift, but has held it like Æsop's "dog-in-a-manger." It seems surely evident that the law which makes such gifts of nature private property was the outgrowth of conditions vastly different from those which exist to-day.

It is a curious illustration of our blind adherence to past traditions and written laws that in England itself ways have been found to escape from some of the rigorous conditions which we still impose on ourselves as a result of our inheritance. An English city, wishing to take water from a certain district to supply its needs, does not have to condemn and purchase at exorbitant figures all the water powers fed by the impounded streams as an American city is compelled to do. The English city simply turns, from the reservoirs which it builds, enough water into the streams to maintain the *low-water* flow unimpaired. The water-power owner has as much water for his mill as before and is further benefited by relief from the danger of floods.

Still more remarkable are the fetters with which we bind and hamper enterprises for the public benefit. Even when an American city has gone to vast expense in securing a water supply and has condemned and purchased water powers for that purpose, it has been claimed that the city could not itself utilize and benefit by the water power which was created as an incidental to its storage of water. Fortunately this perversion of laws, made supposably for the public interest, to serve private ends has generally been overruled.

In the development of water for irrigation purposes there has been comparatively little conflict thus far between private owners of water-power rights and the public use for irrigation. This has been partly due to the fortunate fact that most of the water-power sites in the arid region of the West still remained in Government ownership when the Government irrigation work was undertaken.

In the reclamation work carried on by the Government in the arid West, water power is developed in many cases as an adjunct to the irrigation works and is often of great value, as many of these reclamation projects are located where fuel is expensive. The revenue gained from the sale of such power is applied towards paying the cost of the works.

It is in connection with the use of rivers for navigation that the necessity for public control of water-power development has been in recent months most forcibly brought home to the public. The control by the Federal Government of navigable rivers makes it necessary to secure from the Federal authorities permission to dam or divert the waters of any stream on which navigation may be carried on. Further than this, the work undertaken by the Government itself in improving rivers for navigation by building dams and locks upon them often creates valuable water powers.

In the past, such water powers have been at times turned over to private parties at a nominal rental, and the location of such powers and the fact that in the design of the works navigation and not power development has been the controlling idea, has often hindered the rental of such powers on a remunerative basis.

These conditions, however, are sure to be changed. The Federal Government is likely to undertake navigation improvements on some of the chief rivers and in connection therewith it is almost certain to embark on the great task of the regulation of interstate streams for the checking of floods and maintenance of the low-water flow. The result of such works will be the creation of many new sites for water-power plants and multiplication of the available power at many sites where water-power plants now exist. That private interests will seek to reap the benefit from this expenditure of public funds is certain; and they will make a hard fight to this end, for the prize is a rich one. The equities of the case are so clear, however, that these interests seem doomed to defeat. Where any public body—be it the national government, or a state or a city—creates a valuable water power in the course of its work for water supply, for irrigation, for navigation or for river control, that value belongs of right to the body that creates it.

To establish this principle is of enormous importance. The way is open for carrying out public works of vast value to the people, provided the benefit from such works in the way of water-power development can be made a public asset to bear part or all of the burden of cost. And further, if this principle is established, then works can be planned and carried out for the public benefit where the creation of power is a primary consideration.

The value of the undeveloped water powers of the country and the public rights therein, have been brought forcibly home to the people by President Roosevelt in connection with congressional legislation granting franchises for the use of such powers. On March 13, 1908, President Roosevelt wrote a letter to the Senate Committee on Commerce, in which he called attention to the frequent failure to guard the public interest in the grant by Congress of water rights to private companies and said:

> "The effect of granting privileges such as are conferred by these bills, as I said in a recent message, taken together with rights already acquired under state laws, would be to give away properties of enormous value.

> Through lack of foresight we have formed the habit of granting without compensation extremely valuable rights, amounting to monopolies, on navigable streams and on the public domain. The repurchase at great expense of water rights thus carelessly given away without return has already begun in the East, and before long will be necessary in the West also. No rights involving water power should be granted to any corporation in perpetuity, but only for a length of time sufficient to allow them to conduct their business profitably. A reasonable charge should, of course, be made for valuable rights and privileges which they obtain from the National Government. The values for which this charge is made will ultimately, through the natural growth and orderly development of our population and industries, reach enormous amounts. A fair share of the increase should be safeguarded for the benefit of the people, from whose labor it springs."

This was followed a month later by his veto of a bill relating to a franchise for a dam on the Rainy River, Minnesota, in which he laid down the principles that should control in the grant by the Government of such franchises. He declared that such grants should provide for some license fee or compensation, which, though small at the outset, can in future be adjusted so as to secure control in the interest of the public, and also that the grant should be for some limited term, "leaving to future generations the power or authority to renew or extend the concession in accordance with the conditions which may prevail at that time."

In a second message, in January, 1909, vetoing a bill permitting the construction of a dam on the James River, in Missouri, President Roosevelt again called public attention to the duty of Congress to protect the rights of the public in undeveloped water powers and showed how rapidly the great power plants are passing under the control of large financial interests. Information collected by the Bureau of Corporations showed that thirteen large concerns owned or largely controlled water-power or advantageous power sites equal to nearly one-third of the total water power now in use. Commenting on this condition, President Roosevelt said:

> "The people of the country are threatened by a monopoly far more powerful, because in far closer touch with their domestic and industrial life, than anything known to our experience. A single generation will see the exhaustion of our natural resources of oil and gas and such a rise in the price of coal as will make the price of electrically transmitted water power a controlling factor in transportation, in manufacturing, and in household lighting and heating. Our water power alone, if fully developed and

wisely used, is probably sufficient for our present transportation, industrial, municipal and domestic needs. Most of it is undeveloped and is still in national or state control.

"To give away, without conditions, this, one of the greatest of our resources, would be an act of folly. If we are guilty of it, our children will be forced to pay an annual return upon a capitalization based upon the highest prices which 'the traffic will bear.' They will find themselves face to face with powerful interests intrenched behind the doctrine of 'vested rights' and strengthened by every defense which money can buy and the ingenuity of able corporation lawyers can devise. Long before that time they may, and very probably will, have become a consolidated interest, controlled from the great financial centres, dictating the terms upon which the citizen can conduct his business or earn his livelihood, and not amenable to the wholesome check of local opinion."

This declaration by the President received almost unanimous approval in the public press; but it encountered the bitter opposition of those interested in water-power development enterprises. These people, and those who speak for them on the floor of Congress and elsewhere, maintain that the water powers in question are as much private property as the land itself and that the Federal Government has no right to go one step beyond the protection of the interests of navigation. They deny the right of the public to share any part of the profit from the development of such powers by the imposition of licenses, and aver that even if the public has a claim upon the power because of its being a free gift of nature, that right belongs to the separate states and not to the nation.

There is, indeed, much to be said in support of the latter view, particularly where the older states are concerned; but it is noteworthy that the interests engaged in water-power development are as unwilling to admit the claims of the states themselves as of the nation. A notable example is found in the state of New York, where Governor Hughes in his first message called attention to the potential value of the state's undeveloped water powers and urged that: "they should be preserved and held for the benefit of all the people and should not be surrendered to private interest." Following out this policy, in 1907 Governor Hughes vetoed a bill granting a franchise for power development on the St. Lawrence River and was successful in securing a revision of the law by which the company receiving the franchise is to pay a substantial annual rental into the state treasury.

It may be of interest to see what would be the logical outcome if we were to accept the claims of those who would limit the Federal Government to the control of navigation interests solely. Suppose it to be established that the Federal Government and its officials are limited strictly to the use of rivers for navigation. Manifestly, then, all work done by the Federal Government for river improvement must be done with this sole end in view—as indeed it has for the most part been done in the past. The use of a river to create power, to irrigate farms or even to supply a city with potable water as well as the opportunity to restrain its floods and maintain its flow unimpaired must all take second place to the use of the streams for navigation.

Now, as a matter of fact, the use of a river for navigation is its least valuable use. All other uses confer greater benefit upon the public. Manifestly, then, it is against public policy to confine the Federal Government's functions in the treatment of rivers to navigation solely. Federal action for the control of our great rivers is far more needed and would be far more beneficial for water-power development and for regulation of the volume of flow than for navigation.

But if the theory of the defenders of private water rights holds good, the least beneficial use of our streams must take precedence over all others and we shall see such absurdities as the taking of water from streams for public water supply condemned because of injury to navigation.

In the older states of the East, the right and duty of the states to control water-power development within their borders is rapidly being established. The State of New York leads all others in water-power resources. The 1909 report of the State Water Supply Commission showed 828,784 horse power already developed by water in New York. Step by step, by the logic of necessity, the state has been forced toward the policy of state control. The problem of flood prevention, of water supply to the state canal system, of protection of cities from water famine in drought and of the best development of the vast water powers of the state still unharnessed all conspire to force the state itself to undertake the work. For years state commissions have been studying the subject. It has been attempted to control a river's flow and develop its water power by assessing the benefits upon all the riparian owners affected, including cities, counties and other public bodies. It was found impossible to finance the work so planned.

The latest report of the State Water Supply Commission comes out strongly for state control and it summarizes the "Reasons for State Control" as follows:

> "Aside from the need so emphatically expressed by Governor Hughes of conserving this resource to the use of all the people, there are reasons why the state, which has a far wider scope than any lesser authority, could more advantageously supervise the development and administration of its rivers. By means of a comprehensive policy, taking into consideration present and future development of all parts of every stream, the state can control hydraulic development step by step as conditions demand and eventually realize the most complete and economic utilization possible.
>
> "Development by private enterprise, on the other hand, involves necessary limitations and wasteful methods. Individuals or corporations cannot exercise the necessary power of condemnation required for the creation of water storage. Co-operation between a number of mill owners for the purpose of river control is peculiarly difficult to arrange and the benefits hard to apportion to the satisfaction of all. As a result private enterprise seeks conditions promising the greatest immediate return on the capital invested. This frequently involves the development of only the major portion or 'cream' of a given fall, leaving the remaining portions above and below undeveloped, while effectually estopping their development by any other company or even by the state.
>
> "On the other hand, the state, in such a case, having the financial ability to make great expenditures, and to wait many years, if necessary, for the return on its outlay, could build the works necessary to utilize the entire fall of the river without waste. Such development could be carried forward in sections, as a market for the controlled water or for the developed power might arise from time to time. The essential point is that the development be in accordance with a pre-established plan.
>
> "Such foresight on the part of the state in the control and development of its rivers would also provide for the location of mills, railroads and other industrial structures in such a way as not to interfere with the eventual construction of the necessary storage works. This is an important factor. Had the policy of water-power development by the state for its benefit and the welfare of the people been established earlier as one of the fixed purposes of the state, there is but little doubt that all of the improvements at Tupper Lake Junction could have been as well placed with slight, if any, additional cost to the individuals and corporations concerned, outside the area of possible state work. If the railroad companies and lumbermen had so co-operated in locating the line of the road, its switches, roundhouses, etc., and in selecting sites of the great lumber mills and other interests, a great reservoir which would benefit all of these institutions and many more could be

> constructed for a few thousand dollars where it now will take as many millions. . . .
>
> "It thus appears that the widest possible distribution of benefit will result only when the state itself undertakes the supervision of the construction of storage reservoirs. Such constructions under private enterprise are peculiarly apt to be unsatisfactory in every way from the public point of view."

Another important reason for Government control of water-power development is that public safety may be secured. Experience has abundantly demonstrated that when private enterprise wholly without public control attempts to deal with natural waterways, there will be many cases of incompetence and neglect with consequent disaster. Of the terrible casualties which such incompetence can cause, it is sufficient to refer to the Mill River catastrophe in Massachusetts; to the Johnstown flood in Pennsylvania, and to the breach in the banks of the lower Colorado River which came so near flooding and destroying for a century to come the possibilities of a great undeveloped region in the far southwest.

These and similar disasters furnish ample proof that private interests cannot safely be allowed to tamper with the water courses of a nation, and that any work done upon such streams should be under such supervision as will guard the public interests and the public safety. It is noteworthy that this fact has been recognized and made the basis of legislation in the smallest state of the Union. Rhode Island has for years had a Commissioner of Dams and Reservoirs, charged with the supervision of all structures erected to impound natural waters.

It is true that thus far the actual development of water power in this country is almost wholly in the hands of private enterprise. A few cities have developed water-power plants for municipal lighting, notably Chicago, which, in connection with its great drainage canal, has developed a large water power. Illinois is to undertake a $20,000,000 work for navigation within its borders with the expectation that the water power thereby developed will be of such value as to repay the entire outlay. Los Angeles, on the 240-mile conduit which it is building for a water supply, will develop a large amount of power. It may be said, however, that direct state work in the development of water power is still in the future.

In other countries, however, the state control and utilization of water power has proceeded much farther than in our own avowedly democratic country. In France, in Switzerland, in Italy we find great strides being made to secure for the people at large the benefit from water-power development and to restrict and limit the rights which the owners of lands adjacent to a waterfall may exercise. In Switzerland particularly, with its wealth of water power, the bulk of the water-power development has been done by cities and cantons for their own use.

Our own law of riparian rights, by which the owner of land on a river's bank has thereby rights to the use of its waters, we obtained from our mother country, England, and in England to-day that law is still unquestioned. The reason is easily seen. British water powers are all trivial in size and in commercial importance. There is not the slightest reason why they should not be left in private hands.

Far different is the situation in the English colonies. In Australia water is a precious commodity. In the colony of New South Wales the Government retains the ownership of a strip of land sixty-six feet wide along all waterfronts, and thereby extinguishes all riparian rights which would interfere with the public use of the rivers for power, for irrigation, for water supply, and even for fishing.

Not long since, the writer received a letter from a well-known American engineer, who has held high position in both state and federal service, and who is now in charge of important work in Australia. Contrasting the Australian treatment of water rights and our own, the writer of this letter remarks:

> "All over the West water is going into the control of syndicates and trusts, and in the East the water power which ought to be treasured as a public resource to give its benefits to all is passing into the ownership of the predatory stock jobber and the people at large derive no benefit from it whatever.
>
> "It is a prodigal, blind, unpatriotic notion along every line which has to do with public resources or the public good. When are we to wake up?"

But we do not need to go to the antipodes to find examples of radical treatment of water-power monopolies. Our own near neighbor, Canada, in its chief province, Ontario, has already established a Government Commission to deal with this problem. That commission made an exhaustive investigation to determine the actual cost of water-power development and of electric transmission. Armed with this data, it was able to purchase power on reasonable terms at wholesale from one of the companies which has developed Niagara power on a large scale. The commission is itself undertaking the distribution and sale of that power to various cities in western Ontario.

Two alternatives are before the people of the United States. The first is to permit the water-power resources of the nation to be exploited solely by private enterprise and for private enrichment. Such a course means either that only a small percentage of the possible power can be developed, or that state or national funds must be expended on the work of river regulation and the largest share of the benefit will be reaped by the water-power syndicates. It is true that after a lapse of years the rates charged by private water-power companies may be subject to regulation by law, but one recoils before the long vista of agitation, legislation and litigation which such a course would make necessary.

Is there not a better way to protect the interests and property rights of the public in this great national resource? The other alternative is that better way. The public, through state or federal authorities, should assert its rights to control all undeveloped water powers as well as the increase of power which may be brought about at developed power plants through water storage. Private property owners must, of course, be justly treated; but where their rights have to be extinguished by condemnation, it should be at a really fair value and not at the exaggerated valuation often placed on water-power plants. For it should be understood that over a large part of the eastern United States, where cheap coal is available, the cost of steam power has been brought to so low a point in recent years that water power has to be developed at very low cost to enable it to successfully compete with steam.

Yet this, it must be remembered, is a passing condition. The coming exhaustion of our stores of mineral fuel is certain to be reflected in higher prices for coal and consequently higher cost of steam power before the present generation has passed away. To the next generation the "white coal" of the waterfall will be as valuable here as it is now in Switzerland or Italy. We may therefore readily preserve the benefit of this great natural resource to future generations and at the same time give full scope to private enterprise and energy. Let the government, state or federal, supervise the development of water powers as a part of the large work of river regulation and control. Let it retain the title to our great water-power resources, granting franchises to private companies to use the power for limited terms of years under proper restrictions and with suitable rates of compensation.

Only by the adoption of such a policy can the great water-power resources of the nation be effectively developed. Only by such a policy can the great value of these resources be conserved for the people as a whole instead of exploited for the enrichment of the few.

FEDERAL CONTROL OF WATER POWER IN SWITZERLAND

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On October 24 and 25, 1908, by a vote of 292,997 to 52,180, the people of Switzerland adopted an amendment to the Federal Constitution which gives to the Swiss Federal Government the supervision of the utilization of water power. The text of this amendment is as follows:

> "Article 24b. The Union has supervision over the development of water powers.
>
> "The Federal Congress shall regulate the disposal and terms of water-right concessions, as well as the transmission and delivery of electrical energy, so far as the protection of public interests and the proper development of these resources require such regulation.
>
> "Wherever Federal law does not regulate the terms of the water-right concessions, the disposal of these concessions, as well as the determination and collection of taxes and fees for their use is under the jurisdiction of the Cantons. But this regulation by the Cantons shall not be so onerous as to discourage the development of water powers.
>
> "In cases where water power is developed on streams which touch upon the territory of several Cantons, or upon the National boundary, the disposal of the concessions and the determination of the taxes and fees to be collected by the Cantons will rest with the Union, after hearings have been given to the interested Cantons.
>
> "The delivery abroad of energy developed from water power requires the consent of the Federal Council.
>
> "The provisions of the Federal law apply also to the already existing water-right concessions, unless exception is expressly made."

It is now fifteen years since the question of giving to the Union jurisdiction over the utilization of water power was first agitated in the Swiss Congress. The history of the effort to secure the necessary legislation, down to the adoption of the new amendment, is of great interest in the United States, where the equitable use of water power is in the forefront among the problems dealing with the conservation of natural resources.

When the Federal regulation of water power was first agitated in Switzerland, the utilization of water power was in the hands of the Cantons, except for the provisions of Articles 23 and 24 of the Federal Constitution, which had some distant bearing on the subject. Article 23 gave the Union the right of expropriation, for the purpose of establishing or maintaining public works in the interest of the Swiss Republic. Article 24 gave the Union the supreme control over the water and forest police in the mountainous district of the country, and was meant to safeguard the mountain streams and to aid in forest planting about their sources.

In 1894 the "Frei Land Company," an industrial organization, petitioned the Federal authorities that the Constitution be amended so as to make all water powers not yet utilized the property of the Union, and to make their exploitation subject to Federal control. The Executive Council called in experts to consider this petition, and consulted the cantonal governments. On June 4, 1894, it reported to Congress adversely upon the petition, opposing it on the ground that it tended to create a state monopoly of water powers. The Council also made certain recommendations with regard to future legislation by the Cantons, and reserved the right to propose some new bill dealing with inter-cantonal relations in the establishment of hydro-electric projects.

So the matter rested until 1898, when a resolution was offered in Congress which proposed not only that the inter-cantonal relations in establishment of hydro-electrical projects be regulated, but that deficient cantonal laws be supplemented, and the Union be empowered to supervise the erection of hydraulic works.

In 1901 Congress requested the Executive Council to examine into the advisability of electrifying the Swiss railways.

In 1902 a resolution was offered, which pointed out the danger of permitting private interests to acquire, more or less without restriction, such water powers as might be needed in electrifying the railways. This resolution enumerated a number of points requiring legislative regulation, and laid special stress upon the duty of safeguarding the public interests in the utilization of water power. It was adopted in 1904.

In 1906 resort was had to the initiative. An initiative petition bearing 95,290 signatures urged an amendment of the Constitution which would give the Union power to regulate the utilization of water powers and the transmission and delivery of the energy produced therefrom, leaving to the Cantons and to those legally authorized by them the right to levy the taxes and fees to be paid for the use of the power. The amendment also gave to the Executive Council the power to sell or lease water powers to foreign corporations. The text of the initiative amendment was as follows:

> "ARTICLE 23b. The Federal Congress shall have power to regulate the exploitation of water powers and the transmission and delivery of the energy developed therefrom.
>
> "But the several Cantons, or those duly authorized by them, shall be entitled to the taxes and fees paid for the use of water power.
>
> "From the date of the adoption of this article all new concessions of water rights shall be subject to future Federal legislation, and the delivery of energy developed from water power to foreign countries shall be subject to the approval of the Executive Council."

According to the usual procedure, this petition was referred by Congress to the Executive Council for report.

On March 30, 1907, the Executive Council made its report to Congress. This report reviewed the earlier petitions and resolutions dealing with the Federal regulation of water power, and concluded that the amendment proposed in the petition was open to improvement. The Council was of the opinion that the Constitution should be so amended as to provide for legislation upon the four following points:

1. The systematic utilization of inter-cantonal and boundary streams.
2. The supplementing of deficient cantonal laws.
3. The rights of the Union as proprietor of the Federal railroads.
4. Measures in the interest of the general welfare.

In order to frame an amendment which would give the Union the necessary powers without infringing upon the rights of the Cantons, the Department of the Interior called together a commission of jurists and experts. This commission met in Bern on January 9, 10, and 11, 1907, and adopted a new draft of an amendment as follows:

> "ARTICLE 24b. The development of water power is under the supervision of the Union.

"The Federal Congress shall regulate the disposal and terms of water-rights concessions, as well as the transmission and delivery of electrical energy, so far as the protection of public interests and the proper development of these resources require such regulation.

"Wherever the Federal law does not regulate the terms of water-right concessions, the disposal of such concessions, as well as the determination and collection of the taxes and fees for their use, is under the jurisdiction of the Cantons. But this regulation by the Cantons shall not be so onerous as to discourage the development of water powers.

"When the streams from which the power is developed lie in several Cantons, or along the national boundary, the disposal of the concessions and the determination of the taxes and fees shall rest with the Union, after hearings have been given to the interested Cantons.

"From the date of the adoption of this article all new concessions of water rights shall be subject to future Federal legislation, and the delivery of energy developed from water powers to foreign countries shall be subject to the approval of the Executive Council."

The Executive Council, in its report, then carefully compared the commission's amendment with the amendment proposed in the initiative petition. It pointed out that the initiative petition deprived the Cantons of all jurisdiction over water powers and left to them only the right to collect the charges made for the use of the water powers. This it criticised adversely, as tending toward Federal ownership or monopoly of water powers. It approved the change made in this respect by the expert commission, which proposed that in the jurisdiction over water powers there should be the same division of authority between the Union and the Cantons as already existed in the case of hydraulic works, forests, and game protection. It held, with the expert commission, that when water powers lay wholly within a single Canton it would be sufficient to give the Union supervisory powers which would enable it to protect the public interest and guarantee the proper development of water power resources, but that in the case of inter-cantonal and boundary streams the Union should be empowered to dispose and fix the terms of water right concessions, after hearings given to the interested Cantons. In the absence of Federal legislation, it held, also in concurrence with the commission, that the Cantons should retain jurisdiction, since the right of supervision would enable the Federal authorities to intervene when necessary, either on their own initiative or at the request of some interested party.

The Council further criticised the initiative petition for its failure to provide a basis for future legislation. It pointed out, also, the need of a verbal change in section 4 of the commission's amendment, so as to enlarge its provisions to cover streams or water courses which flow between Cantons as well as those which are strictly inter-cantonal. Finally, it suggested the change in the last section which provides that future Federal legislation shall apply to existing water right concessions unless exception is expressly made.

The Council closed its report by recommending a substitute amendment based upon both of the proposed amendments before it, and embodying the fruits of the above criticism. The petitioners had authorized the withdrawal of their amendment in favor of such a substitute, and in due course the amendment recommended by the Council was put to vote, with the result already given.

According to the practice, the amendment was published and commented on by the Swiss press. The following clipping from one of the local papers is of interest as showing how great was the importance attached to the amendment by the Liberal Democratic Party:

"THE WATER RIGHTS ARTICLE.

"The central committee of the Liberal Democratic party of the Canton of Bern issues the following appeal:

"'Fellow-citizens! On the national election day you are to vote upon an amendment to the Federal Constitution, which would grant to the Union the right to control by legislation the use of water power and the transmission of the energy developed therefrom. In order that our valuable water powers may be developed systematically for the benefit of the country, uniform principles of proper use are to be laid down. The Cantons will retain the rights which they can properly claim and which they have effectively exercised hitherto. To the Union will be given the duties which the Cantons cannot discharge, but which need to be regulated by the Union if development is not to be permanently crippled. Thus far only a small part of our water power has been utilized; we have been paying every year a tribute amounting to millions of Marks in the purchase of coal, etc., abroad, though a great part of this sum could be kept at home if our water powers were better utilized. Yet petty considerations and unworthy special interests are preparing in different places to defeat this measure. For this reason those who truly appreciate its great importance must take their stand with determination and work hard for its adoption. The issue is the protection of great national resources, the advancement of the economic interests of all Switzerland, and therefore of the general welfare of the fatherland.'"

PART THREE

Conservation and Use of Land Resources

CLASSIFICATION OF THE PUBLIC LANDS

BY GEORGE W. WOODRUFF,

ASSISTANT ATTORNEY-GENERAL FOR THE DEPARTMENT OF THE INTERIOR, WASHINGTON, D. C.

SUMMARY OF OUR MOST IMPORTANT LAND LAWS

BY HON. KNUTE NELSON,

UNITED STATES SENATOR FROM MINNESOTA; CHAIRMAN OF THE SENATE COMMITTEE ON PUBLIC LANDS, AND CHAIRMAN OF THE COMMITTEE ON LANDS, NATIONAL CONSERVATION COMMISSION.

INDIAN LANDS: THEIR ADMINISTRATION WITH REFERENCE TO PRESENT AND FUTURE USE

BY HON. FRANCIS E. LEUPP,

COMMISSIONER OF INDIAN AFFAIRS, WASHINGTON, D. C.

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BY CYRIL G. HOPKINS,

CHIEF IN AGRONOMY AND CHEMISTRY, UNIVERSITY OF ILLINOIS AGRICULTURAL EXPERIMENT STATION, URBANA, ILL.

FARM TENURE IN THE UNITED STATES

BY HENRY GANNETT,

GEOGRAPHER, UNITED STATES GEOLOGICAL SURVEY, WASHINGTON, D. C.

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BY HON. FREDERICK H. NEWELL,

DIRECTOR, UNITED STATES RECLAMATION SERVICE, WASHINGTON, D. C.

THE LEGAL PROBLEMS OF RECLAMATION OF LANDS BY MEANS OF IRRIGATION

BY MORRIS BIEN,

SUPERVISING ENGINEER, U. S. RECLAMATION SERVICE, WASHINGTON. D. C.

CLASSIFICATION OF THE PUBLIC LANDS

By George W. Woodruff,
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Washington, D. C.

Each citizen of the United States owns an equal undivided share in the public domain. This has included all the land in the Continental United States and Alaska except the original thirteen colonies and the present states of Texas, Kentucky and Tennessee. The original public domain of the United States proper was 1,441,436,160 acres, of Alaska 368,103,680, and thus would have totaled 1,809,539,840 acres if none of the land had been disposed of. Under the constitutional provision that "Congress shall have power to dispose of and make all needful regulations respecting the territory or other property belonging to the United States," Congress has from time to time enacted, modified and repealed laws for the disposal of the public land, and the total area, exclusive of Alaska, has been reduced to approximately 380,000,000 acres.

The large membership of Congress, the conflicting desires of various portions of the country and of great private interests, and the fact that a minority can prevent the passage of laws desired by the majority, have caused mismanagement of the public domain. In the early days, the pressure of what then seemed a great national debt led to the disposal of the land for revenue. This continued until the homestead law was enacted as a recognition that the establishment of homes and home improvements is a greater return to the Nation than a few dollars per acre. Since that time all the nonmineral public lands have been open to settlement by citizens of the United States who are willing to make farm homes. The immense area of the public land, however, made it practically impossible to determine whether any particular tract was or was not mineral.

Congress provided for the sale of our splendid timber land at a uniform price of $2.50 per acre, evidently on the theory that it was necessary to place a bonus upon the institution of lumber operations. This forest land is now worth from ten to one hundred times the purchase price of $2.50 per acre. Some of it has been saved to the people by the law providing for national forests; but before the possibilities and wisdom of their rapid creation was understood by the executive branch of the Government the bulk of the best timber land had passed into private holding. In this great estate of the people there were about 150,000,000 acres of land underlaid with valuable coal, and not legally open to homesteaders, but the Land Department, because of lack of funds, was unable to save fully 100,000,000 acres of the best of this coal.

From the above it is evident that the one great business need of the Government as steward of the peoples' landed estate, was such a classification of the land and resources as would have made it possible to devote the various areas to their best uses. The location and quality of at least the coal and other minerals which occur in great beds, could have been readily determined. The areas more valuable for permanent reservation for the use of all the people as national forests and national parks could have been found before the best part of them were gone. Invaluable reservoir and water-power sites could have been determined and held for use under proper regulation. The remaining area would have been left for the homemaker. Such a classification would have brought to the attention of Congress in an irresistible way, and before selfish prejudices against the proper disposal of the land had become acute, the propriety of dividing land not only by vertical planes as is now the custom, but by horizontal planes in cases where fine agricultural surface is underlaid with valuable mineral.

In 1796 Congress, in providing for the survey of the public lands, required (1 Stat. 466) the surveyors to note in their returns "the true situation of all mines, salt licks, salt springs and mill sites coming to their knowledge, and water courses over which lines of survey should pass," and also the quality of the lands. The same law required that these returns should be submitted to the surveyor-general, who was required to "cause a description of the whole lands surveyed to be made out and transmitted to the officers who may superintend the sales." This provision is carried into section 2395 of the Revised Statutes and has been in force for more than a century. It is a sad fact, however, that the returns of surveyors are for the most part worse than none at all, since they are woefully inaccurate and misleading.

The surveyors-general's offices throughout the public land states naturally came to be a source of political patronage, and the surveyors-general and their deputies were not appointed for reasons of efficiency. For that reason Congress was seriously considering in 1876 the abolition of these offices, and Professor F. V. Hayden, in a hearing before the House Committee on Public Lands, stated:

> "If the deputy surveyors could be required to bring in on their plats the information that is demanded, there would be no necessity at present for a bureau for information as regards the classification and irrigation of lands." (Forty-fifth Congress, second session, House Mis. Doc. 55, p. 19.)

The need for classification so worked upon the minds of Congress that in the Sundry Civil Bill of June 20, 1878, a clause was inserted that:

> "The National Academy of Sciences . . . at their next meeting take into consideration the methods and expenses of conducting all surveys of a scientific character under the War and Interior Departments and the surveys of the land office, and report to Congress as soon thereafter as may be practicable a plan for surveying and mapping the territories of the United States on such general system as will, in their judgment, secure the best results at the least possible cost."

In the proceedings of the committee appointed by the Academy, Major J. W. Powell said:

> "In the administration of the laws relating to these (public) lands those belonging to each specific class must be determined; *but no adequate provision is made for securing an accurate classification, and to a large extent the laws are inoperative, or practically void;* for example, coal lands should be sold at ten or twenty dollars per acre, but the Department having no means of determining what lands belong to this class, titles to coal lands are usually obtained under the provision of statutes that relate to lands of other classes; that is, by purchasing at $1.25 per acre, or by homestead or pre-emption entry. An examination of the laws will exhibit this fact, that for the classification contemplated therein a thorough survey is necessary, embracing the geological and physical characteristics of the entire public domain. The only provision under the general land office for such a survey is contained in the 'instructions to the surveyor-general.' (*Vide*, p. 18, and paragraphs under the head of 'Summary of objects and data to be noted.') In the performance of those duties the deputy surveyors, who do the work under contract, fail entirely to provide the facts necessary to the proper administration of the laws, and, in practice, the facts upon which transactions in the department are based are obtained not from experts employed as government officers and competent

> to perform the task, but on affidavit made by the parties interested, or by persons selected by them, and the history of the land office abundantly exhibits the fact that states and individuals have to a large extent obtained titles to lands from the government under fraudulent representations.
>
> "From the above statement it will be apparent that a thorough survey of the geology and physical classification of the entire domain *is necessary to the administration of the laws relating thereto.*" (Forty-fifth Congress, third session, H. Mis. Doc. No. 5, pp. 19, 20, 21.)

The National Academy Committee after recommending that surveys should be made by the Coast Survey, which was well fitted to make and complete them, went on to say:

> "The best interests of the public domain require, for the purposes of intelligent administration, a thorough knowledge of its geological structure, natural resources and products. The domain embraces a vast mineral wealth in its soils, metals, salines, stones, clays, etc. *To meet the requirements of existing laws in the disposition of the agricultural, mineral, pastoral, timber, desert and swamp lands, a thorough investigation and classification of the acreage of the public domain is imperatively demanded.* The committee, therefore, recommend that Congress establish, under the Department of the Interior, an independent organization, to be known as the United States Geological Survey, to be charged with the study of the geological structure and economical resources of the public domain, such survey to be placed under a director, who shall be appointed by the President, and who shall report directly to the Secretary of the Interior."

The House passed a bill February 25, 1879, in which all the recommendations of the Academy were accepted, but the Senate committee reported the bill on February 28th, with all these provisions stricken out. Evidently foreseeing the defeat of these unusually wise measures Mr. Atkins, Chairman of the House Committee on Appropriations, inserted in the Sundry Civil Bill an item of $100,000 "for the expenses of the geological survey and *the classification of the public lands, etc.*"

Thus, at a time when classification would have been of untold value, we see an awakened consciousness in Congress that their trusteeship of the public domain demanded an investigation and classification of its nature. Unfortunately the wise impulse led to practically nothing. The provision that the Geological Survey should classify has been almost nullified by lack of necessary appropriations. Besides this lack of means to classify there followed a period of quiescence both in Congress and in the executive branch of the

Government concerning the need for properly administering the public land. During that period, which extended to President Roosevelt's first term, seventy-five per cent. of the valuable part of our land passed into private possession either in accordance with the law or, not infrequently, contrary to the law.

The last administration sought vigorously to do all that could be done with the insufficient and inefficient laws at its disposal. During Mr. Roosevelt's presidency the area of the national forests was trebled, thus classifying the public land valuable for timber and watershed protection purposes. President Roosevelt withdrew about 68,000,000 acres of the coal land to hold it from disposal until it might be classified. The bulk of this land has been classified and the classification of the rest will be practically complete at the end of the coming field season. The Reclamation Service has withdrawn large areas for its projects under the Reclamation Act thus classifying the bulk of the irrigable land remaining. President Roosevelt also withdrew a great area of phosphate and oil lands. One of the last acts of Secretary Garfield, acting for the President, was to withdraw several hundred reservoir and water-power sites from all form of disposition except under the appropriate right of way laws. All these withdrawals, however, are simply acts of the executive to protect temporarily the public property and it is the part of Congress to pass the badly needed laws to devote permanently the public lands and resources to their best use.

The conclusion to be drawn from the conditions set forth above is that either the remaining public land must be disposed of to the disadvantage and irreparable loss of its owners, the people, or Congress must be speedily aroused to the great fundamental principles: That the surface of land more necessary for public use for conserving water run-off, unusual natural scenic beauties or wonders, timber and forage, than for homemaking, should be held by the Government permanently for the use of all the people and maintained effectively in a condition to insure its highest efficiency for all time; that the surface of land chiefly valuable for agriculture should be disposed of only to actual homemakers in areas reasonably capable of supporting families; that the right to exploit the mineral resources belonging to the nation should be reserved and granted only to those who actually intend to exploit them, in such limited areas, for such periods, and under such conditions as will for each class of mineral bring about its seasonable and economical exploitation, but prevent such monopoly as may injure the interests of the people; that rights of way which depend upon the peculiar formation of any of the public lands should be permitted for definite and limited periods only, varying for each class of right of way, with reasonable conditions to protect the public interest, but with certainty to the permittees against revocation during the permit period for any cause except non-use or misuse; and that, pending disposal or reservation of the public land, it should be administered and protected as far as each class of land is concerned by that governmental agency best fitted in each case to handle it efficiently.

A SUMMARY OF OUR MOST IMPORTANT LAND LAWS

By Hon. Knute Nelson,
United States Senator from Minnesota; Chairman of the Senate Committee on Public Lands; and Chairman of the Committee on Lands, National Conservation Commission.

Aside from several acts providing for the satisfaction and location of warrants, issued for military service, and a number of acts relating to special and limited grants, the first act of a general character making provision for the survey and disposal of our public lands was the act of May 18, 1796 (1 Stat. 464). The title of this act is as follows: "An act providing for the sale of the lands of the United States in the Territory northwest of the Ohio River and above the mouth of the Kentucky River."

This act outlined and prescribed the system of surveying the public lands, in its essentials since adhered to, and provided for the disposal of the surveyed lands at public sale, partly on credit, to the highest bidder. The amendatory act of May 10, 1800 (2 Stat. 73), while adhering to this system of public sales, provided that lands not disposed of at any such sale might be sold at private sale, but in neither case at less than $2 an acre. By the act of April 24, 1820, sales on credit were abolished and the minimum price at public and private sale was fixed at $1.25 per acre, at which rate it has since remained. Lands, thus open to private sale, became known thereafter as offered lands, while surveyed lands that had not been exposed to public sale became known as unoffered lands. This act also gave a pre-emptive right to the extent of a section—640 acres—at $2 per acre, to any person who had erected or had begun to erect a grist or saw mill on such section of land, subject to public or private sale. From this time on settlers on public lands were tolerated, and as a rule not deemed trespassers; and from time to time various acts were passed giving pre-emptive rights to those who had made settlements prior to the passage of the laws.

The first pre-emption law, however, of a general character, and prospective and continuing in its operation, was the act of September 4, 1841 (5 Stat. 453), authorizing a settlement to be made on surveyed land, to which the Indian title had been extinguished, and giving a pre-emptive right thereto. This was subsequently amended so as to extend to unsurveyed, as well as surveyed land, to which the Indian title had been extinguished and which was not included in any reservation. The head of a family, a widow, or a single person over twenty-one years of age, who was a citizen or had declared his or her intention to become a citizen of the United States, and who was not the owner of 320 acres of land and who did not quit his own land to reside on the public land, was qualified as a settler and pre-emptor, under these laws. No settler could acquire more than 160 acres. If the settlement was made on offered land the settler must, within thirty days after initiating his settlement, file a notice and statement of his claim at the district land office and must make his final proof and payment for the land within twelve months after initiating settlement. If the settlement was on surveyed and unoffered land, he must file his statement within three months and make final proof and payment within thirty-three months from date of settlement; and if the settlement was made on unsurveyed land he must file his statement within three months after plat of survey was filed in the district land office and make his final proof and payment within thirty-three months thereafter. The minimum price was $1.25 per acre. The law contemplated that the settler should occupy, improve and cultivate the land from date of first settlement until final proof and payment. The land department permitted final proof and payment to be made at the expiration of six months from date of settlement and much laxity prevailed in the district offices in the matter of proof of settlement and cultivation. Oftentimes claims were allowed to be "proved up" when there had been little or no residence, and the scantiest kind of improvements on the land. Payment could be made in cash, military bounty land warrants, agricultural college scrip, and a few other kinds of scrip. *Bona fide* settlers, as a rule, took the extreme time limit of the law for making final proof and payment and where they were unable to pay, they converted their claims into homestead entries, under the homestead law of the United States, as they had the right to do. Much of the land was "taken up" under the law by mere speculators who would "prove up" as soon as they could and then sell their claims for what they could get and leave the country.

In March, 1889, the law, allowing land to be secured at private sale, or by "private entry," was repealed, and thereafter the preemption law was utilized on behalf of those who desired to secure valuable timber lands and other lands in large quantities by hiring young men and women to "take up" pre-emption claims, and taking a transfer from them on "proving up," and paying them for "their time and trouble." The pre-emption law was finally repealed in March, 1891, as well as the law permitting public sales. The homestead law furnished ample facilities for the honest settler to acquire a home, while the pre-emption law had become, by this time, to a large extent, a mere instrument for acquiring land for speculative purposes, hence its repeal. It ought to have been repealed when the homestead law was enacted.

The most important, in many respects, of all our land laws, the law under which so many poor people have been enabled to secure for themselves happy homes, and under which our country has been so rapidly developed and settled, is the homestead act of 1862, a veritable home-builders' law. Under this law, as now amended, every person who is the head of a family, or who has arrived at the age of twenty-one years, and who is a citizen, or has declared his intention to become a citizen of the United States, and who is not the owner of 160 acres of land, may enter one quarter section or less of the "unappropriated public lands," at the district land office. After making such entry he must establish his residence on the land within six months thereafter and must continue from thenceforth to reside upon, cultivate and improve the land for the period of five years, at the end of which time, or within two years thereafter, on furnishing the required proof of compliance with the law, as to residence, improvement and cultivation, he is permitted to make final entry of the land, without paying anything therefor, except the land office fees, and thereupon patent will issue to him in due course. A person who has only declared his intention to become a citizen when making his first entry must be fully naturalized before he can make the final entry. Under the original law the homesteader acquired no right to the land before he made his first entry at the land office; but under an amendment to the law a homesteader may settle on unsurveyed land, and if he then makes entry of the land within three months after the plats of survey have been filed in the district land office his right to the land will date from the time he initiated his settlement. In case the homesteader is unwilling to reside upon the land for the five years and is willing to pay for the land, he can "commute" his entry as under the pre-emption law. Originally he could "commute" after six months' residence, as under the pre-emption law, but under the law of 1891 this period was extended to fourteen months. "Commuting" consists in furnishing proof of residence and cultivation for the period of fourteen months and paying the minimum price, $1.25 per acre, for the land. The land department originally construed the act of 1891 by counting the period of fourteen months from the date of the entry and inasmuch as the entryman had six months in which to establish his residence upon the land, it led to a residence and cultivation requirement of only eight months. This rule has now for some time been abandoned and fourteen months of actual and continued residence and cultivation is now required before an entry can be "commuted." The homestead law has proved a great blessing to the poor and needy settler in enabling him to pay for his farm by merely residing upon, improving and cultivating the same for the period of five years. Starting without any capital, except a zealous spirit and strong arms, he finds himself at the end of five industrious years the possessor of a good home, worth from three to six thousand dollars, and meanwhile he has been paying his taxes, furnishing trade and traffic for the merchant and the railroad, and living immune from the controversies recurring between capital and labor, because, in his case, capital and labor have been concentrated in one head. The one defect of the homestead law that has, to some extent, marred its greatest usefulness, has been the permission to "commute" and make final entry before the end of the five-year period. This was especially glaring and pronounced while "commutation" could be made in six months, and it is still very bad under the fourteen-months' limitation. The evil lies in the fact that so many "take claims" because of the commutation privilege, not for the purpose of a permanent home, but merely for the purpose of securing the land to hold for speculative purposes, as middle-men, to sell out at a profit to some actual and permanent settler. The real settler is in no hurry to make proof and final entry. He oftentimes avails himself of the seven-year period. It is, as a rule, the speculator—the man who does not care to live on the land—who is in a hurry to "prove up," and "commute," as it enables him, sooner or later, to levy tribute on the actual and real settler. The speculative homestead commuter is not a home-builder, and does not deserve our help or sympathy. The area of public lands, suitable for farms, is rapidly diminishing, while our population is even more rapidly increasing. In times of great industrial stagnation, our public lands have proven a great safety valve—have proved themselves the haven where poor and industrious laboring men, forced out of employment and without work, could go to work in creating happy homes for themselves and their children, immune from the industrial stress prevailing in our large cities and manufacturing centers. This safety valve, this haven, should be preserved as long as possible, and the repeal of the "commutation" provision of the homestead law is one of the important means of such preservation. None but the real home-builders should have the benefit of that law.

Another important land law remains to be noticed. I refer to the timber and stone act of June 3, 1878, originally limited to the states of California, Oregon, Nevada and Washington, but subsequently, by the act of August 4, 1892, extended to all the public land states. Under this law any person who is a citizen, or has declared his intention to become a citizen of the United States, may purchase and acquire title to 160 acres of unappropriated, uninhabited and unreserved non-mineral public land of the United States, unfit for cultivation, and valuable chiefly for timber or stone, at the minimum price of $2.50 per acre. Only one tract of 160 acres can be purchased by any person and before he can purchase the same, he must present to the register of the district land office his sworn statement, specifying, among other things, that he does not apply to purchase the same on speculation, but in good faith to appropriate it to his own exclusive use and benefit, and that he has not, directly or indirectly, made any agreement, or contract, in any way or manner, with any person by which the title he may acquire shall inure to the benefit of any person but himself. False swearing renders the purchaser guilty of the crime of perjury and involves a forfeiture of the land and the money paid therefor. On its face this law, at first blush, seems harmless, and as though it was merely intended to give a settler an opportunity to secure some stone or timber for his own use and as an appurtenance to his farm holding, but no land law has proven more baneful in its operation to the welfare of the country than this. It has been made the vehicle through which a few of the big lumbermen of the country have secured and monopolized thousands of acres of our most valuable timber lands, and this has been carried on to such an extent that but a limited supply would still remain were it not for the fact that we have, in recent years, put much of our timber lands in forest reservations.

The mode in which these lumbermen have carried on their operations has been, in the main, and in outline, this: They have, in person or through agents and employees, secured, by divers means, a large number of men and women, in various parts of the country—people who knew nothing about such lands, and who had no thought of acquiring the same—to apply to purchase and enter such lands, supplying them with money to travel from remote, interior towns to examine and select the land and make the necessary application to purchase at the district land office, and supplying them with money to pay for the land, and then after the purchase and entry were completed procure a conveyance of the land to themselves for a moderate bonus. These dummy purchasers—for they were in fact in most cases nothing else—would be approached in the first instance like this: "I know where you can make some money by taking a timber and stone claim. It will cost you only $2.50 per acre and you can easily sell it as soon as you get title for an advance of $200 or $300, or perhaps more." "But I have no money with which to go and examine and purchase the land." "That does not matter; I know a friend who will advance you the money and will take the land off your hands at a good profit as soon as you get title, but you must keep this matter to yourself." The temptation to make money in this easy way is so alluring that many act on the suggestion and thus become the instrumentality of the big lumberman. I remember how, a few years ago, a large number of lady school teachers in a western city—the headquarters of some big lumbermen—were induced to "take up" timber and stone claims in Oregon, Washington and California, more than 1500 miles from where the teachers lived. Most of these lands afterwards passed into the hands of these lumbermen.

A large portion of our timber lands in the western states, outside of the government forest reservations, has, in recent years, largely under operations such as I have mentioned, passed into the hands of large lumber syndicates, who have well-nigh secured a monopoly of our timber supply. There are still in various localities in the western states bodies of timber land that ought to be preserved and conserved for the present and future welfare of the people of the United States. These lands ought not to be sold, but should be retained by the Government and the timber on them should be conserved, and only the old and mature timber should, from time to time, be sold under suitable rules and regulations, to the end that our people may not become entirely helpless under the timber monopolies now hovering like a dark cloud over our country.

Holding these views, to me it seems clear that the timber and stone law should at once be repealed. Nearly five years ago the Senate passed a bill repealing the law, but the bill met with defeat in the House. While much has been lost since then, there is still something to save, and speedy action should be taken.

It remains to notice another important land law, now obsolete, which, while passed for a good purpose, proved, to a large extent, abortive and a source of speculation. I refer to the timber culture act of March 13, 1874, entitled "An act to encourage the growth of timber on the western prairies," largely amended and modified by the act of June 14, 1878. As thus amended and modified, the law authorized the entry of a quarter section, or less, of treeless land, by any person who was the head of a family, or who had arrived at the age of twenty-one years, and who was a citizen, or had declared his intention to become a citizen of the United States, for the purpose of timber culture. The conditions for acquiring a complete title were, in brief, that the entryman should plant, protect, and keep in a healthy, growing condition for eight years ten acres of timber on a quarter section, five acres on an eighty, or two and one-half acres on a forty-acre tract. On furnishing proof of compliance with these conditions final entry would be allowed and patent would issue. No residence on the land was required. In its practical operation it took ten years to acquire full title under this law. The first year was devoted to breaking the land, the second year to planting the trees, and the remaining eight years to the care, growth and propagation of the trees. The purpose to promote the growth of timber on the western prairies was most laudable, but to a large extent, partly through climatic conditions, but largely through neglect and want of care on the part of the entryman, comparatively few claims became forested or timbered. The entryman was usually one who held a homestead or pre-emption claim, and he took advantage of this law to get another 160 acres of land. He would break and plant, but *not* otherwise give much attention to the trees. He would do just enough to keep the land in chancery for ten years, in the meantime keeping others from getting it, then "prove up" his homestead, or pre-emption claim, and then relinquish his tree claim and enter the land either under the homestead or pre-emption law, whichever of the two rights he had not used and exhausted. Then, too, many tree claims were "proved up" on, to say the least, very questionable, if not perjured, testimony. Another favorite way was for the timber entryman, after holding his claim for two or three years, to relinquish his claim for a good consideration in favor of some settler who was anxious to secure the land as a homestead. There was quite a speculation for a time in timber claim relinquishments. In short, the law, in its practical operation, proved, on the whole, a rather scant timber producer, and the source of some fraud and much speculation. By the act of March 3, 1891, the law was finally repealed with some saving provisions for existing claims.

There are some other important land laws, such as the desert land law, the reclamation land law, and the so-called Carey law, all relating to the reclamation and settlement of arid lands, which are local in their scope and which I can not well describe in detail without unduly enlarging this paper. Various kinds of land scrip, or quasi-scrip, available for the location and entry of public lands, have, from time to time, been issued, such as military bounty land warrants, agricultural college scrip, Sioux half-breed scrip, Chippewa half-breed scrip, soldiers additional, Valentine scrip, Porterfield scrip, Supreme Court scrip, surveyor general scrip and forest reserve scrip. Most of this scrip has now been exhausted and but little of it remains to be located.

It must further be noted that large quantities of public lands have been, at various times, directly or indirectly, granted to railroad companies to promote the construction of railroads. Years ago there were limited grants made for the construction of canals and other waterway improvements, and for wagon roads; and the states, too, have received large and liberal grants for educational purposes, for reclaiming wet and overflowed lands, and for other purposes of internal and municipal improvements.

From this brief review of our public land system—if indeed such a varied and heterogeneous course of procedure can be called a system—it appears that the Government started out with the idea that it was desirable to dispose of the land as soon as possible at the highest obtainable price. The land was regarded simply as an asset to be converted into cash as soon as possible, hence the plan of public sale supplemented private sales. Many of the pioneers and frontiersmen, however, who pressed into the wilderness to make homes, were too poor to pay for the land immediately. So, in the first instance, they became mere squatters, but as they, and not the speculators who bought at public sale, were the real settlers who occupied, subdued and improved the public domain and became the nucleus and founders of municipal government, the Government began to see the necessity of giving them a helping hand. While still adhering to the purchasing idea, it gave them a first chance to buy, with a brief breathing spell in which to raise the necessary funds. Hence came the many special, and ultimately the general pre-emption, laws. The settler must still buy at the same price as the speculator, but he was given a chance to make a short start on his claim before paying the price. By and by, after much controversy, Congress finally came to the conclusion that it was more important to have the public domain "settled up," as rapidly as possible by real home-builders, even without compensation, than to get money and turn the land over to a lot of middlemen for exploitation and profit. Hence came our homestead law, the wisest and best of all our varied land laws. While most of the lands, taken under our other land laws, have passed into the hands of real settlers and home-builders, yet these have had to render a large tribute to the speculators and middlemen who first purchased from the Government. The tribute these men received has been greater than the tribute they rendered the Government in the first instance.

My conclusion, from this brief survey of our land system is, that in view of the rapid increase of our population and in view of the rapidly diminishing area of our public domain, no agricultural land should be disposed of except under the homestead law without the "commutation" privilege; that none of our remaining forest lands should be disposed of, but only the large and mature timber; and that our arid lands should be disposed of for agricultural purposes to actual settlers under the reclamation law.

INDIAN LANDS: THEIR ADMINISTRATION WITH REFERENCE TO PRESENT AND FUTURE USE

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From the genesis of the freehold the relation between land and the degree of civilization of the people living thereon has been very close. Economists have recognized this fact, and it has formed one of the premises of political economy from the founding of that science. That the welfare of a people has its tap-root literally in the soil has come to be regarded as axiomatic; hence it is that the administration of Indian lands constitutes a very large part of what is known as the "Indian Problem"—the effort of the United States, as guardian or trustee, to civilize the Indian race and make it self-sustaining.

It may be said in passing, and enlarged upon later, that the present administration of Indian affairs takes cognizance not only of the interests of the Indians, but also of those of the whites, and gives proper weight to the justifiable selfishness which insists upon such method of administering the lands of the Indian wards as will have due regard for the rights of their trustees.

It is impossible adequately and intelligently to discuss the present administration of Indian lands without a retrospective glance at the steps by which the policy now followed has been reached. At the time of the discovery and settlement of America the many Indian tribes inhabiting that part now embraced within the limits of the United States were recognized by the various governments under whose authority settlements by whites were made as separate and independent communities. As the country gradually filled up, and as the demands of increasing population required, the United States, which had succeeded in turn to the rights of Great Britain, Spain, France and Mexico, under the pressing necessity of obtaining complete possession of the territory east of the Mississippi, adopted the policy of extinguishing, by treaties, the title of the various tribes to the land they had occupied, assigning to each a district or reservation of land of smaller area, yet commensurate with the Indian modes of life and subsistence, within whose limits it was protected in the enjoyment of a modified or local sovereignty.

This was the beginning of the "Reservation System," a system whose evils it requires the larger part of the energy of recent Indian administration to remedy; and it is to be noted that in laying the foundation for this anomalous maintenance of nations within a nation, the Indians were not yet recognized as wards of the Government, but were treated with as distinct though dependent nations, and their right to the lands occupied by them was recognized in formal treaties. Most of the reservations, each a princely domain, were west of the Mississippi and on land for which it was then thought the white settler would have no need for centuries if at all; and the right of perpetual possession was guaranteed the Indians.

Then came the railroad and telegraph, and, almost overnight, wrought the changes of centuries under the old régime. When time and space had been annihilated, land which had been waste and useless suddenly became not only desirable but necessary for the extended development of the national interests.

As the whites increased in number and power and in time surrounded the reservations with farms and towns, they were prevented from entering and taking possession of the lands of the Indians only by an enforcement of treaty obligations. It was not long before the situation thus created was recognized as impossible, and under one and another pretext large areas of reservation land were thrown open to general settlement. With this change came also, partly under the guise of compensation for the lands thus taken, and partly as the simplest way of keeping alive a people whose means of subsistence, the hunt, had been destroyed, the abominable ration system, with its resultant pauperization of the Indian race. It will be seen before I close this discussion that much of the present method of administering Indian land matters is aimed at, or modified by, the necessity of combating the results of this deadly blow at the real welfare of the Indian.

Three epochal departures mark the transition from the method of treating the Indians and their lands which I have just outlined, to the present system. They are the Act of March 3, 1871 (16 Stat. L., 566), the Act of February 8, 1887 (24 Stat. L., 388), and the decision of the United States Supreme Court in the case of Lone Wolf against Hitchcock rendered on January 5, 1903.

The first of these, which declared that thereafter no Indian nation or tribe within the territory of the United States should be recognized as an independent nation or tribe with whom the United States might contract by treaty, was the initial step in the recognition of the ultimate use of Indian lands. By depriving the Indian tribes of the treaty-making status, Congress gave itself the power the more closely to scrutinize proposed contracts or agreements with them and to alter such agreements for the public good without the consent of the Indians.

The next step logically, though not chronologically, was the decision of the Supreme Court referred to, which held in effect that the United States was not bound to regard the terms of its treaties with Indians made prior to the Act of March 3, 1871, when the public welfare, or the real interest of the Indians, was no longer subserved by their observance. By this act and this decision the Government of the United States, largely represented in its relations with these people by the Office of Indian Affairs, was given the power, with the concomitant responsibility, of working out with a free hand the salvation of the Indians and the administration of their lands to the best interest of all concerned.

Midway in point of time between the act and the decision referred to came the Act of February 8, 1887, variously known as the "Dawes Bill," from its author, the late Senator Henry L. Dawes of Massachusetts, the "Severalty Law," and the "General Allotment Act," which provides that the President may, in his discretion, allot the Indians their lands in severalty in specified quantities, and that the surplus lands may then be disposed of in manner agreed upon, the proceeds going to the Indians.

Rightly understood, this act was the "Magna Charta" of the Indian, though the emancipation it brought was forced upon him reluctant and protesting, instead of being demanded by him. At the same time it provides automatically for opening to white settlement the thousands of acres of Indian land not actually needed by the Indians.

The Severalty Act was designed to change the wandering, improvident and semi-civilized hunter to a domestic, industrious and enlightened citizen. As the first step to this end the law contemplated giving to each Indian a home, and that the home in the first instance should be agricultural. The first industries were to be the primal ones of farming and grazing. In this new mode of life the guardianship which theretofore had been exercised over the tribes was transferred to a guardianship over the individual allottees. The separate manhood of each Indian was recognized, but for a time he was to be subject to the care and supervision of the Government as trustee. Recognizing that the Indian could not be made overnight into a business man qualified to care for his own interests, the law was so conditioned that during a period of wardship and tutelage of at least twenty-five years the allottee should not be subject to entering into unequal competition with whites in the field of traffic and general business outside of agriculture and grazing. At the end of the twenty-five-year trust period, the Indian would be presumed to have advanced so far in civilization as to be competent to manage his own affairs, whereupon a fee patent would issue to him, and the leading-strings between himself and a paternal government would be severed finally.

The reservation system had the effect of stunting endeavor to the extent of suppressing the chief motive of human effort—self-preservation. Moreover, bitter experience had led the Indian to conceive a racial dislike to the white man, whose good faith he suspected. By nature he is averse to common hard labor, has no idea of saving for to-morrow, and abhors restraint and discipline.

It is not to be wondered, therefore, that when the Allotment Act was passed, the red men evinced a sharp repugnance to the whole program contemplated. They objected to the disruption of the old tribal ties, to the distribution of their lands, and to the demand that they should farm. In many cases the greatest difficulty was experienced in inducing members of bands to take up their allotments. Even where reservations were broken up and the allotted land accepted, often no disposition was displayed by the allottees to compass the essential object of supporting themselves. They simply sat down and let things drift or indulged in their old time diversions of dancing and gambling, and in most cases the Government thought it expedient to continue the accustomed distribution of rations for a greater or less period.

For twenty-two years the Office of Indian Affairs has been engaged in the execution of the General Allotment Act, and various special acts having in view the same purpose but adapted to the varying conditions of different tribes. The general law, for example, provides for the allotment of eighty acres to each member of the tribe where the land is recognized as agricultural, and 160 acres where it is fit only for grazing; but in a large part of the frontier West it has proved difficult to classify the lands satisfactorily.

Even where classification is simple the general law sometimes proves defective on other points. Most of the reservations yet to be allotted contain little or no agricultural land that can be cultivated without irrigation. Eighty acres of irrigable land is vastly more than an Indian can utilize, and, owing to lack of funds, the cost of irrigating so great an area is almost prohibitive. All who know Indians are aware that no people are so easily discouraged by being given a task which seems to them beyond their powers. Hence, in allotting to an Indian a tract of land larger than he can hope to till—especially when his tenure of the water necessary to make it productive depends upon his beneficial and continued use thereof—would be to place upon him not only a physical but a moral handicap.

On the other hand, 160 acres of grazing land is entirely inadequate in those regions where the main industry is raising cattle. Where it requires forty acres to a head of cattle, and 100 head of cattle to furnish means of support for a family, an allotment of 320 acres of grazing land will not solve that family's economic problem.

Not infrequently where reservations are opened by special acts of Congress, the primary object appears to be to hasten the date when the surplus unallotted lands can be taken by the home-seeker, and not enough thought is given to the condition of the Indians to be allotted, or to the ultimate welfare of those whites who will acquire homes on the coveted lands or will eventually succeed, through purchase, to a large share of the allotments.

I think the remedy lies in vesting greater authority in the Department, by passing a general law allowing not less than five or more than forty acres of irrigable land, or more than 640 acres of grazing land, to each Indian, in the discretion of the Secretary of the Interior. This not only would enable the Department to care properly for the interests of the Indians, but would result also in the more rapid opening of reservations and the consequent dissolution of the generally condemned reservation system. The development of the frontier West would thus proceed to the ultimate advantage of both Indian and white citizens, and automatically.

Like their white neighbors, Indians are of more than one sort, ranging from good degrees of intelligence, industry and thrift to the depths of helplessness, ignorance and vice. Experience has proved that Indians of the former class do better when allowed to run their own business than when the Government tries to run it for them; but that citizenship and jurisdiction of the local courts are of no advantage to Indians of the latter class because the community as a rule does not interest itself to compel the proper exercise of police and judicial powers in behalf of any group of people who constitute a mere waste element and bear no share of the tax burden.

Such conditions made plain the need of some law which would enable the Indian Office to manage the affairs of the helpless class with undisputed authority, but, on the other hand, to remove from the roll of dependents the ever-increasing number of Indians who no longer need Government supervision, yet who could be emancipated only by a special act in each case. To this need came a response from Representative Charles H. Burke of South Dakota, who procured the passage of an act modifying the Dawes law by postponing the citizenship of all Indians allotted after May 8, 1906, till the termination of the trust period, but giving authority to the Secretary of the Interior to terminate the trust period by issuing a patent in fee whenever he is satisfied of the competency of any individual allottee to manage his own affairs. It also provides that on the death of an Indian allottee his allotment may be canceled and patent in fee issued for the canceled allotment to the heirs of the deceased allottee; or the Secretary of the Interior may cause the land to be sold as provided by law and issue a patent therefor to the purchaser, paying the net proceeds to the heirs or their legal representatives.

The legislation of recent years shows conclusively that the country is demanding an end of the Indian question, and this is right. The Burke law is accomplishing more in this direction than any other single factor developed within a generation. Competent Indians, owning their land in fee and receiving their portions of the tribal property without restrictions, cannot by any course of action maintain a claim for further consideration. Through such measures and their application, the grand total of the nation's wards is diminishing daily and with a growing ratio, more than 3500 applications for fee patents having been approved in the three years the Burke law has been in effect.

From what I have written it will be seen that for twenty-two years the Indian department has been required to administer two classes of Indian lands—the reservations, and the lands held in trust for individual allottees—and it will be engaged in this dual work for a few years to come. After that there will be no reservations; white settlers will have all the surplus lands, their farms will join those of the Indians, and the latter, by the removal of restrictions, will pass rapidly from the trusteeship of the Government into the care of their owners; and thus, in about a generation, "Indian lands" and the "Indian problem" will simultaneously disappear in the vortex of a general American citizenship. Let me trace now, briefly, some of the specific methods employed in administering these two classes of lands.

I have said that the Indian was reluctant to use his land either for farming or for stock-raising. Partly as an example to arouse emulation and partly to prevent needless waste, the policy of leasing tribal lands was inaugurated, and this was the earliest use made of strictly reservation lands. This policy is still in vogue, and hundreds of such leases are made every year.

No authority existed for leasing allotted lands until February 28, 1891, when an amendment to the General Allotment Act provided for leasing allotments on reservations "bought and paid for" by the Indians. Under this act (26 Stat. L., 794), as amended by the Acts of June 7, 1897 (30 Stat. L., 85), and May 31, 1900 (31 Stat. L., 299), the terms for which allotted lands may be leased are limited to three years for grazing and five years for farming purposes, except unimproved allotments on the Yakima Reservation in Washington, which may be leased for agricultural purposes for a period not exceeding ten years, on such terms and conditions as may be prescribed by the Secretary of the Interior. The Act of April 30, 1908 (35 Stat. L., 70), authorizes the leasing of allotted lands susceptible of irrigation in the former Uintah and Umcompahgre Reservations in Utah, with the consent of the allottees, for terms not exceeding ten years; and the same act extends the term for leasing lands susceptible of irrigation on the Shoshone Reservation in Wyoming to not exceeding twenty years in the discretion of the Secretary of the Interior. More than 7300 such leases were approved between August 15, 1907, and August 15, 1908. My own modification of this policy, as Commissioner of Indian Affairs, has been to permit progressive allottees to make their own leases and collect their own rentals free from departmental supervision, and in the same period more than 2900 Indians have been accorded this privilege.

Next in order is the use of timber on reservations and allotments, and here enters what is perhaps the most important single policy in my handling of Indian affairs—a policy which has been extended to reclamation work, and which I hope to see made to cover many other phases of administration.

As to timber: The Indians have the right to apply to their own use and benefit the entire products of a reservation, whether the result of their own labor or of natural growth, if they do not commit waste. If the lands in a state of nature are not in a condition for profitable use, they may be made so; if wanted for the purpose of agriculture, they may be cleared of their timber to such an extent as may be reasonable under the circumstances, and the surplus timber thus removed and not required for use may be sold by the Indians.

There is no general law authorizing the sale of growing timber on Indian allotments and reservations. The Act of February 16, 1889 (25 Stat. L., 673), provides that the dead timber, standing or fallen, may be cut and removed with the consent of the President. Under this act sales have been made from time to time.

Article 3 of the Treaty of September 30, 1854 (10 Stat. L., 1109), with the Chippewa Indians of Lake Superior and Mississippi, authorized allotments with only such restrictions as the President might see fit to impose. Under this article the President has approved regulations under which allottees of the Bad River, Lac du Flambeau, Lac Courte Orielles and Red Cliff Indians have been authorized to sell their timber.

The Act of April 21, 1904 (33 Stat. L., 209), gave to the Chippewas of Minnesota the right to sell their timber on the allotted lands with the consent of the Secretary of the Interior, and under this act the Secretary has promulgated regulations for Indians of the Leech Lake, Grand Portage and Fond du Lac Reservations.

Operations are now in progress on the Menominee Reservation in Wisconsin, under the terms of the Act of March 28, 1908 (35 Stat. L., 61), which authorizes the cutting of timber, the preservation of the forest and the manufacture and sale of lumber on that reservation.

The Supreme Court in United States *vs.* Paine Lumber Company (206 U. S., 467), decided that the Stockbridge and Munsee Indians in Wisconsin were authorized to sell the timber on their allotments without governmental supervision. Even with such limited authority millions of feet of timber are logged yearly, and the Department is endeavoring to obtain legislation authorizing the sale of mature timber on all Indian lands, whether allotted or unallotted.

Where the present administration has made its impress upon the forestry and other classes of work under its supervision is in the way of systematic co-operation between various departments and bureaus of the Government, so as to get rid of the "wheels within wheels" which are so grave a source of waste in administration For example, the Office of Indian Affairs, when I assumed charge of it, not only performed the functions naturally to be expected of a benevolent guardian engaged in raising a race of human beings from barbarism to civilization, but maintained a little forestry branch, a little reclamation service, and several other minor organizations for work along lines commonly cared for, and presumptively better cared for, by special bureaus established by law for the benefit of the American people at large. Recognizing the broad economic principle that no extensive public work can be conducted so successfully on a retail as on a wholesale basis, and as the needless multiplication of machinery for doing the same class of work tends to retard rather than advance the attainment of the ends sought, I opened negotiations for a co-operative arrangement with the Forest Service, and under date of January 22, 1908, the Secretary of the Interior and the Secretary of Agriculture entered into an agreement by the terms of which the Forest Service is making a careful study of the forests on Indian reservations, for the purpose of determining the best permanent use of the lands. When these are found more valuable for forest purposes than any other, it prepares and applies plans for their management; it sells such timber as may be cut without injury to the forests; it supervises the logging under methods which will improve the forest and yield the full market value of all the timber cut; and it protects all forests on Indian reservations whether or not they are being cut over. While the salaries and expenses of the men employed to carry out this agreement are paid by the Indian Office, all the men employed are responsible only and directly to the Forest Service.

A still larger field for increased co-ordination is found in irrigation work which is going on now all over the West. Within the last ten years this subject has taken such strides in public interest as to astonish even those who are the most enthusiastic advocates of the artificial reclamation of our deserts. Irrigation has come to play so large a part in the agriculture of the West that it is almost impossible to separate the two ideas. Tracts of Indian country which were made into reservations long before there was any general knowledge of irrigation, and which were then supposed to be comparatively valueless except for grazing or mining, are now proving to be well adapted to general agriculture, even including some of its more delicate forms, if water can be put upon the soil.

The problems pertaining to the development and preservation of an adequate water supply for the irrigation of Indian lands are of a nature demanding the most careful study. The Indian Service has its own irrigation corps and system; but here again, as in matters affecting timber lands, the problems to be worked out on Indian reservations are often so closely allied with problems involving large areas of country opened to white settlement as to make the union of the Indian irrigation projects and the white irrigation projects really essential to the success of both.

To that end I have perfected an agreement with the Reclamation Service whereby there are turned over to that service those irrigation projects into which both white and Indian interests enter, reserving for the Indian Office those which are purely Indian propositions; but even in the latter class the irrigationists of the Indian Service have the benefit of the expert advice and assistance of the consulting engineers of the sister service. Such a combination procures for the Indians the best the Government can command in the way of irrigation plans and work, and reduces the chances of serious mistakes to a minimum. Under such conditions large works, involving the expenditure of several million dollars, mostly reimbursable from future sales, are under way or projected on the Gila River Reservation, Arizona, the Flathead, Blackfeet and Fort Peck Reservations in Montana, the Fort Hall Reservation in Idaho, the former Uintah Reservation in Utah, and the Shoshone or Wind River Reservation in Wyoming.

It is apparent that in the rapid opening of reservations, the severing of the tribal relations as far as possible, and the invitation to white occupancy of lands formerly locked within the confines of reservation boundaries, the protecting arm of the Government has been withdrawn in a large degree from the ward who heretofore has been so dependent upon it. Many problems will arise in the future, and it must needs be that some of the weaker of this race go down that their stronger fellows may attain to the full measure of citizenship. It is impossible to foresee all the difficulties which may present themselves, and they will have to be met as they arise in the manner which seems most equitable to all interests concerned.

But it must be apparent that through the present policy of the Government in administering Indian lands due regard is had to the proper interests of the whites. Any other policy would not result in the real betterment of conditions for the Indians, for it would unnecessarily retard the growth of the State or Territory within whose boundaries Indian lands lie, and the individual Indian, like the individual white, rises or falls in prosperity with the prosperity of the community in which he lives and of the country which surrounds him.

THE CONSERVATION AND PRESERVATION OF SOIL FERTILITY

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Within a hundred miles of the spot where the first permanent English settlement was made in our country one can to-day buy hundreds of thousands of acres of arable land for less than $10 an acre—land that was once valued at $50 an acre, and would now be worth more than $100 an acre if its fertility had been maintained. This statement does not include any reference to lands that have seriously suffered from soil erosion, but only to great areas of nearly level or gently undulating farm lands whose productive power has been almost destroyed by a hundred years or more of common cultivation by American farmers.

The two and one-half billion bushel corn crop of the United States is mostly produced on land not subject to injury by surface washing, and in the main this is also true of the half-billion bushels of wheat from the principal wheat-producing states.

The greatest material problem of the United States is not in the development of the waterways, not in the preservation of forests, and not in the conservation of our coal and iron, important as these all are; but the problem that is vastly greater than all of these is to bring about the adoption of systems of farming that will maintain or increase the productive power of American soils.

We must not deceive ourselves with general statistics which show some increase in average crop yields in some states. Thus, in the new state of Illinois the average yield of corn has increased in the past ten years, but this does not prove that Illinois soils are growing richer. During the past ten years the annual corn area of Illinois has increased from 7 million acres to 9 million acres, and the added 2 million acres are the richest black soil of the state, reclaimed by dredge ditching and tile drainage; while the 7 million acres are producing smaller crops than ten years ago.

It is sometimes asked how it is that the soils of Rhode Island and Connecticut produce more corn per acre than those of Illinois.

Because Rhode Island and Connecticut make large use of plant food materials, including much manure produced in part from Illinois corn, oats and bran. It is well to know, however, and well to remember, lest we be deceived by false arguments, that the corn acreage of Rhode Island is less than half of one township; that the corn acreage of Rhode Island and Connecticut combined is less than one-tenth of one Illinois county; and that the total corn acreage of Rhode Island, Connecticut, Massachusetts, Maine, New Hampshire, Vermont, New York, New Jersey, Pennsylvania, Delaware and Maryland all combined is less than the corn acreage of Georgia. The acreage of corn in Illinois is twice as large and the average yield three times as large as that of Georgia.

It is sometimes asked how it is that the old lands of Germany, for example, produce more wheat per acre than the United States. Lest we be deceived, we should know that Germany produces 125 million bushels of wheat, and, in addition, Germany imports 75 million bushels of wheat, 40 million bushels of corn, more than a billion pounds of oil cake, and other foodstuffs from which much manure is made; and, besides all this, Germany uses large quantities of phosphates and other commercial plant food materials.

And what does Germany export? Her principal export is two billion pounds of sugar, which contains no plant food of value.

Similar statements may be made of England, France, Belgium, Holland and of all small countries, or small states, or small districts near large cities where the productive capacity of the soil is maintained. Thus Denmark produces 4 million bushels of wheat, and in addition Denmark imports 5 million bushels of wheat, 15 million bushels of corn, 800 million pounds of oil cake and other foodstuffs, phosphates, etc., and Denmark exports 175 million pounds of butter, which contains no plant food of value, but which sells for more than these imports cost.

If anyone knows anything of American agriculture he knows that, as a general rule, old land is poorer than new land; that the practice of the present art of agriculture tends toward land ruin. Therein lies the fact that points toward future poverty for our children. If old lands were richer than new lands, then would the soils of old Virginia be more valuable than those of Illinois. The United States is one of the greatest agricultural countries, and without agriculture America is nothing.

There are but three other great agricultural countries comparable with the United States. Consider for a moment their history and present condition: China, India, Russia—names almost synonymous with famine, where millions of people die of starvation every few years.

Not only on the black cotton soils of India, where five acres of land are now required to produce one bale of cotton; not only on the black earth soils of Russia, where eight bushels is the average yield of wheat, with fallow every third year, but also on the black corn soils of America, the practice of the art of agriculture tends toward land ruin.

If the art of agriculture has reduced the productive power of American soil, then the science of agriculture must restore it, and the key to the problem for our most common agricultural land is the element phosphorus. Phosphorus is the only element of value contained in the mineral called phosphate.

There are three elements of plant food that have recognized market values—nitrogen, phosphorus and potassium, and the inventory of our natural resources must include the supply of each of these three elements.

Are our common farm lands rich in nitrogen? No. Do we have anywhere an inexhaustible supply of nitrogen? Yes. There is contained in the air over every acre sufficient nitrogen for a hundred bushels of corn every year for 700,000 years; and this supply can be drawn upon any time and always, both by us and by our children. Indeed, the nitrogen can be gotten from the air not only without expense, but with profit in the getting, because such crops as clover and alfalfa, which by means of symbiotic bacteria have power to utilize atmospheric nitrogen, are valuable crops to raise for their own sake, and where these are plowed under liberally, either directly or in manure, nitrogen is thus supplied for the production of any other crop.

What do we know regarding the element potassium? We know that if the composition of our common plowed soil were the same as the average composition of the solid crust of the earth, based upon the analysis of 2110 samples of common rocks by the United States Geological Survey, then the plowed soil of one acre would contain sufficient potassium for a hundred bushels of corn every year for 2590 years, assuming that the corn stalks are returned to the land, either directly or in farm manure. In other words, potassium is one of the abundant elements in the earth's crust and, consequently, in all normal soils. Thus several hundred analyses by the Illinois Experiment Station have shown that the average corn belt land contains sufficient potassium in the plowed soil for a hundred bushels of corn per acre every year for as long as the time since Christ walked among men—or sufficient potassium for the average corn yield of the United States every year for as long as since Adam began to till the soil. In addition to this are the great potash mines of North Germany, covering a million acres and now estimated to contain sufficient potassium to meet the present rate of production for 190,000 years; and when these are gone the people of earth can recover potassium from the absolutely inexhaustible supply of the boundless ocean, as is already being done to some extent in Southern France.

One hundred bushels of corn contains 19 pounds of potassium and 17 pounds of phosphorus; and, while the average crust of the earth contains two and one-half per cent. (2½%) of potassium, it contains only one-tenth of one per cent. (0.1%) of the element phosphorus; and the most common agricultural lands of the United States contain in the plowed soil no more total phosphorus than would be required for a crop of a hundred bushels of corn per acre during the full life of one man. If such crops had been removed from our common corn belt lands every year since Columbus discovered America they would have required every pound of phosphorus contained in that soil to a depth of four feet.

For the adoption of systems of permanent agriculture under which our common lands shall grow better instead of poorer, the nitrogen problem is to secure it from the absolutely inexhaustible supply in the air, and the potassium problem is to liberate it as rapidly as necessary from the practically inexhaustible supply in the soil, while the phosphorus problem is to get all we can and keep all we get. But what are we doing? We are exporting every year for less than 6 million dollars sufficient phosphorus for the production of 600 million dollars' worth of corn, while the element phosphorus already limits the yield of corn on the commonest corn belt land.

Few scientific facts are better established than these. A single illustration will show the possibility of increasing the productive power of the land with proper treatment and the certainty of soil depletion even under a good crop rotation without the addition of plant food.

For sixty years at Rothamsted, England, the oldest agricultural experiment station in the world, a four-year rotation of turnips, barley, clover (or beans) and wheat has been grown on Agdell Field, where the soil is of normal composition. There are three sections in this field; no plant food has been applied to one, minerals including phosphorus to the second, and the same with nitrogen added to the third. As an average of the last twenty years, corresponding to the average yield just fifty years from the beginning of the experiments, the following results per acre were obtained:

Soil Treatment.	None.	Minerals.	Minerals and Nitrogen.
Turnips, tons	.5	12.6	20.9
Barley, bushels	13.7	22.2	29.2
Clover, tons	.4	1.9	1.7
Beans,* bushels	16.0	28.3	19.6
Wheat, bushels	24.3	38.4	36.4

*Beans were grown where clover failed.

Rapid Land Ruin in the United States

Among all the nations of the earth the United States stands first in rapidity of soil exhaustion. The improvement of seed, the use of tile-drainage, the invention and immediate adoption of labor-saving agricultural machinery, the wonderful development of cheap and rapid means of transportation, and the opening of the world's markets to the American farmer have all combined to make possible and to encourage the rapid depletion of American soils, until agricultural ruin already exists, practically, over vast areas in the older parts of this new country, the United States of America, while it is common knowledge that even in the new rich corn belt most lands that have been under cultivation for half a century are less productive now than they once were.

The almost universal practice of the civilized world to this date has been to ruin land and then to seek out newer lands on which to repeat the process even more quickly. There is extreme poverty among the people of the world almost wherever they are dependent for support upon the agricultural resources of ordinary land that has been under cultivation for two centuries.

If we are ever to adopt systems of soil improvement it must be done while we are prosperous. People living in poverty on impoverished lands have no money to invest in the improvement of their farms, no matter how great returns such investments would promise in future years. Soils that have been running down for a century cannot be built up economically in a year so as to pay an immediate profit on the improvements.

Plant Food in Rich Soils

Lands that are valuable produce large crops. Soils that produce large crops are rich soils. Rich soils contain a large store of plant food. If we are to maintain our lands in a high state of productiveness and at a high value we must maintain in our soils a large supply of every essential element of plant food.

It is worth while to remember that there are ten essential elements of plant food. If the supply of any one of these elements fails the crop will fail. These ten elements are carbon and oxygen, taken into the leaves of the plant from the air as carbon dioxide; hydrogen, a constituent of water, absorbed through the plant roots; nitrogen, taken from the soil by all plants and also secured from the air by legumes; phosphorus, potassium, magnesium, calcium, iron and sulphur, all of which are secured only from the soil.

The soil nitrogen is contained in the organic matter, or humus, and to maintain the supply of nitrogen we should keep the soil well stored with organic matter, making liberal use of clover or other legumes which have power to secure nitrogen from the inexhaustible supply in the air, the clover being plowed under either directly or as farm manure.

It is interesting to know that an acre of soil seven inches deep, if it possessed the average composition of the earth's crust, would contain sufficient iron to meet the needs of one hundred bushels of corn every year for 200,000 years, sufficient calcium for 55,000 years, magnesium for 7,000 years, sulphur for 10,000 years, and potassium for 2,600 years, but sufficient phosphorus for only 130 years.

These numbers are based upon the average composition of the earth's crust in accordance with the most recent computations of Professor F. W. Clarke, of the United States Geological Survey. They are certainly significant to the student of soil fertility, although perhaps no soil possesses exactly the average composition of the entire crust of the earth.

As stated above, the nitrogen resting on an acre of the earth's surface is sufficient for 100 bushels of corn every year for 700,000 years, although the nitrogen contained in the plowed soil of an acre is rarely sufficient for more than fifty such crops.

Only two essential elements of plant food are becoming deficient in the ordinary soils of the United States. These are nitrogen and phosphorus, neither of which is contained in the plowed soil of our commonest lands in larger quantity than would be required for maximum crops during the full time of one life.

There are some soils whose fertility can be maintained at low-yielding power by crop rotation alone. This is on sloping land whose surface soil is washed away at least as rapidly as the fertility is removed by crops and whose subsoil is as rich or richer than the surface in mineral plant food. Some soils of this topography, with subsoils rich in mineral plant food, have been cropped for centuries with the production of two or three grain crops every ten or twelve years, the intervening years providing for the accumulation of nitrogen by legumes while the land is kept in pasture. These lands are valued at about $10 to $20 an acre, and this value can be maintained indefinitely without the application of farm manures or other plant food materials. But it is impossible to maintain our common prairie and level upland timber soils at their present value and productive power if we continue to remove from these lands larger amounts of phosphorus and nitrogen than are returned.

It is certainly good farm practice, and usually the best farm practice, to remove the largest possible quantities of plant food from the soil, for the simple reason that large crops require large quantities of plant food; but it is no less important to restore to the soil, when needed, even larger quantities of plant food than are removed—by turning under legume catch crops and crop residues not removed from the field, by returning manures produced on the farm, and so far as necessary by the purchase of commercial plant food, such as phosphorus in bone meal or rock phosphate, or if needed, potassium in concentrated potassium salts.

Effect of Crop Rotation

It will be well to consider in some detail the effect of crop rotation on soil fertility. Suppose we are practicing a four-year rotation, including corn for two years, oats with clover seeding the third year, and clover for hay and seed crops the fourth year. Let us assume such crop yields as have been produced and as can be produced, in normal seasons on the richest, best treated land, with good seed and good farming, namely, 100 bushels of corn per acre, 100 bushels of oats and 4 tons per acre of clover, including, perhaps, 3 tons in the hay crop and 1 ton in the seed crop. If we do not succeed in securing these yields we should at least try to make such yields possible, and we should approach as near to them as we can. On the best treated land at the University of Illinois 88 bushels of corn per acre have been produced as an average of the last six years, and on three different soil experiment fields in the state we have harvested more than 90 bushels of oats per acre.

Let us first consider the phosphorus required for this rotation. The two crops of corn will each require 23 pounds, 17 for the grain and 6 for the stalks; the oat crop will require 16 pounds of phosphorus, about 11 for the grain and 5 for the straw, and the 4-ton crop of clover will require 20 pounds of phosphorus. Thus we see that 87 pounds of the element phosphorus will be required for the rotation. If we leave the stalks on the land the requirement is reduced to 70 pounds of phosphorus, or to about 17 pounds a year per acre.

Suppose the soil contains in the first 7 inches 1200 pounds of phosphorus per acre, which is about the average of the principal type of soil in the corn belt; how many years would be required to remove this amount from the land if it could be drawn upon at this rate? Only seventy years. On the other hand, suppose with this crop rotation we can secure from the soil the equivalent of only one per cent. of the phosphorus contained in the first 7 inches. This would be only 12 pounds of phosphorus a year, which would necessarily reduce the crop yields much below the amounts suggested above, and with the further reduction in the total amount of phosphorus year by year, the crop yields must be reduced accordingly.

On the ordinary soils of the United States ultimate failure is the only future for this system of farming, even if we consider the phosphorus alone; although the phosphorus may be returned in bone meal, in acid phosphate, in raw rock phosphate, or in sufficient amounts of farm manure.

If we consider the element nitrogen in this system of farming we find that 200 bushels of corn require about 200 pounds of nitrogen, aside from that required for the stalks, and the stalks must be returned to the land without burning, otherwise the 96 pounds of nitrogen required for the two crops of stalks, will also be removed from the land. The oats crop will remove 97 pounds of nitrogen, making 297 pounds per acre for the corn and the oats.

The four tons of clover will contain about 160 pounds of nitrogen and the clover roots and stubble about one-half as much as the tops, or 80 pounds per acre. If all of the nitrogen contained in the entire clover crop is taken from the air the rotation would add only 80 pounds of nitrogen to the soil, while the corn and oats would remove 297 pounds.

How, then, is it possible to maintain the supply of nitrogen by this rotation? It is not possible. Under such a rotation, with all crops removed except the corn stalks, the supply of nitrogen grows less and less. Where this rotation is successful for a time it is due to the fact that the soil nitrogen has been drawn upon year by year, while the chief effect of the clover has been to extract phosphorus from the soil for its own growth and for the use of succeeding crops.

There is another point to be considered in reference to nitrogen. On land that is capable of furnishing sufficient nitrogen for even a 50-bushel crop of corn the clover crop will undoubtedly draw a third of its nitrogen from the soil and not more than two-thirds from the air. Consequently, since two-thirds of the nitrogen in the entire plant is removed in the tops, the roots and stubble will leave no more nitrogen in the soil than the plant takes from the soil. How, then, can we maintain the supply of nitrogen in the soil? By plowing under sufficient clover or by applying sufficient farm manure or, better, by using both of these means.

If all the crops grown in the rotation are fed, including the corn stalks, containing a total of 533 pounds of nitrogen from four acres, and if three-fourths of this, or 400 pounds, are returned in the manure, we have sufficient to replace the 393 pounds removed in the corn and oat crops, and we may assume that the 160 pounds of nitrogen removed in the clover came from the air. Of course, some additional nitrogen will be saved in the straw and stalks which are used directly for bedding and not for feed.

How shall the grain farmer maintain the nitrogen in his soil? Possibly this can be done by plowing under everything produced except the grains and the clover seed, preferably only one corn crop being grown in the rotation.

The problem of maintaining the nitrogen in live stock farming becomes easier if we extend the rotation to include about two years of pasture, using a mixture, perhaps, of red clover, alsike, timothy and red top instead of seeding red clover only with the oats. In this case three grain crops, as corn, oats and wheat, or corn two years and oats one year, could be grown during the six-year rotation, the land being kept in meadow and pasture one-half of the time.

Use and Value of Farm Manure

Farm manure always has been, and without doubt always will be, the principal material used in maintaining the fertility of the soil; but it is an unquestionable fact that the greatest source of loss to American agriculture to-day is in the enormous waste of farm manure. If corn were worth $1.05 a bushel, then the average annual value of the corn crop of the United States would be equal to the average value of the total farm manure annually produced in this country.

The positive or intrinsic value of farm manure lies in the amounts of valuable plant food which it contains. It also possesses an important indirect value as a soil stimulant, due to its power as it ferments and decays in contact with the soil, to liberate from the soil plant food that would not otherwise become available so quickly. There is still another distinct value in farm manure, due to the fact that it makes the soil more porous and spongy and thus increases the power of the soil to absorb and retain moisture and to resist surface washing. This third value of farm manure is due to improvement in physical condition.

The value of farm manure for its physical improvement of the soil is commonly fully appreciated, and frequently overestimated by popular agricultural writers, while its value for the plant food which it supplies and for that which it liberates from the soil is sometimes almost ignored. There is no good excuse for erroneous teaching regarding these different values, because there exists a vast amount of positive information both from practical experience and from exact scientific investigations.

Thus, organic matter from peat beds hauled out and spread on the land and incorporated with the soil produces no such effects on crop yields as are produced by good farm manure. Why? Because the peat does not decay readily, so as to furnish plant food either by its own decomposition or by liberating it from the soil; and yet the peat has as great power as farm manure for physical improvement of the soil.

Manure made from clover hay and heavy grain rations has much greater value than manure made from wheat straw. Why? Is it because they affect the physical conditions of the soil in different ways? No. The great difference in value is due to the difference in plant food and in rapidity of decay.

At the Rothamsted Agricultural Experiment Station, England, on a field to which no manure and no plant food have been applied the average yield of wheat has been 12.9 bushels per acre for more than half a century. Land treated with a heavy annual application of farm manure has produced 35.5 bushels of wheat per acre as an average during 55 years. Another field treated with commercial plant food without organic matter has produced 37.1 bushels of wheat per acre as an average during the same time. The latter field received a little less plant food than was furnished in the manure, thus furnishing ample proof of the value of plant food supplied and showing that the physical effect of the farm manure was by no means so important.

Nevertheless, the physical effect should not be overlooked. Under certain seasonal conditions this physical value may be very important. Thus, in the very dry season of 1893 at Rothamsted the land fertilized with commercial plant food produced only 21.7 bushels of wheat per acre, while the farm manure plot produced 34.2 bushels the same year.

In semi-arid regions the physical condition of the soil and its power to absorb and retain moisture may be the controlling factor in crop yields, but where the average annual rainfall is 28 inches as at Rothamsted or 37 inches as in Illinois, with a fairly uniform distribution during the growing season, the physical conditions of the soil in relation to crop yields may be compared to the shelter and other physical surroundings provided for live stock. In other words, under normal conditions the controlling factor is food, for crops as well as for live stock.

While manure has some value for physical improvement and a larger value in its power to liberate plant food from the soil, it should be clearly understood and always borne in mind that the great value of farm manure, especially in profitable systems of permanent agriculture, is due to the plant food it contains, and that the greatest problem in the handling of farm manure is to prevent the loss of plant food.

The value of average fresh farm manure is about $2.25 a ton, either when determined by chemical analysis on the basis of present market values for the plant food contained in the manure or when determined by the value of the increased crop yields produced when the manure is applied to the fields in ordinary crop rotations.

This means that a pile of average fresh farm manure containing 100 tons is worth $225. If exposed to leaching from heavy rains during only two or three months in the spring the value will be reduced, as a rule, from $225 to about $150 by the loss of plant food without much reduction in total weight. Indeed, the total weight is frequently increased under such conditions because the rain water that remains in the manure may be in greater amount than the urine that has been washed out. Fermentation and additional leaching during the summer may easily reduce the value to $100 or less. There are two satisfactory methods for handling manure. One of these is to haul and spread the fresh manure daily or at least two or three times a week. For this purpose a manure spreader, or, at least, a wagon used for this work only, is very useful and almost necessary. The other method is to allow the manure to accumulate in the stall or covered feeding shed while it is constantly tramped by the animals and kept moist by the liquid excrement, sufficient bedding being used to absorb the excess and to keep the stock clean, and then to haul and spread it on the land when conditions permit. It should not be left, however, to dry out and heat and decompose in the stalls or sheds long after the animals have been turned out to pasture.

Loss of Fertility by Selling Farm Produce

Every system of farming should be so planned as to be both profitable and permanent, which requires that the productive capacity of the land must be maintained. We must understand, then, what the soil contains, what materials are required to produce crops, in which parts of the crops these different materials are deposited, so as to know what part of the produce may be sold and what part should be retained on the farm; also what is done with these important plant food materials when the crops are fed to live stock.

The older prairie and upland timber soils of the United States are, as a rule, exceedingly rich in potassium but relatively deficient in both nitrogen and phosphorus. In the worn hill lands nitrogen is usually more deficient than phosphorus, while in the average long-cultivated prairie soil phosphorus is more deficient than nitrogen.

When grain crops are produced, as corn, oats and wheat, about two-thirds of the nitrogen and three-fourths of the phosphorus, but only one-fourth of the potassium required for the crop are stored in the grain or seed, while about one-third of the nitrogen, one-fourth of the phosphorus and three-fourths of the potassium are stored in the straw or stalks.

Thus a large crop of corn, 100 bushels to the acre, will contain about 100 pounds of nitrogen in the grain and 48 pounds in the stalks, 17 pounds of phosphorus in the grain and 6 pounds in the stalks, 19 pounds of potassium in the grain and 52 pounds in the stalks. Quite similar relations exist between the grain and straw of other crops.

Now, with these facts in mind, it is plain to see that a system of farming by which the grain is sold and only the stalks and straw are kept on the farm and returned to the soil carries off in the grain much of the nitrogen and phosphorus. In both of these elements most soils are more or less deficient, while the potassium, of which the normal soil contains an almost inexhaustible supply, enough in the first 7 inches for 100 bushels of corn per acre every year for seventeen centuries, is largely returned in the straw and stalks.

It should be remembered that legume crops, as clover, alfalfa, cowpeas and soybeans, are rich in both nitrogen and phosphorus, 3½ tons of clover hay containing as much phosphorus and 40 pounds more nitrogen than 100 bushels of corn.

If the crops are fed to live stock, it is well to know that about one-fourth of the nitrogen and one-fourth of the phosphorus are retained in the flesh and bone of the animal, while three-fourths of the nitrogen and phosphorus and practically all of the potassium are returned in the solid and liquid excrement. Thus we have another process of separation by which part of the needed nitrogen and phosphorus leaves the farm with the animals, while the potassium is again returned, even though it may not be needed.

It should be a plain fact that manure made from animal excrements with straw or stalks for bedding must be deficient in nitrogen and still more deficient in phosphorus, but rich in potassium, as compared with the requirements of the crop; and this is especially noteworthy when the manure is to be used on land already deficient in nitrogen and phosphorus but well supplied with potassium.

In the case of nitrogen the difficulty can be overcome by making a liberal use of clover or other legumes in the crop rotation and as catch crops, turning under these crops and crop residues so far as practicable. Legume crops may also be used in pastures to a considerable extent, thus securing nitrogen from the air to balance the deficiency in the manure. With the phosphorus the difficulty is greater, because the proportion contained in the manure is less and there is no such ever-present inexhaustible supply as in the case of nitrogen.

Increasing the Value of Farm Manure

It must be apparent that to increase the value of farm manure we should add phosphorus to it. Thus, we can balance manure, and when used on soils rich in potassium in rotations with nitrogen-fixing legume crops we can provide plant food in a balanced ration to meet the needs of the maximum crop yields. By these means we can check the progress of soil exhaustion and even gradually increase the fertility and productive capacity of the land. Indeed, we can thus profitably enrich such land even beyond its virgin fertility.

By far the cheapest form of phosphorus is fine-ground raw rock phosphate. This material is but slightly available for the use of crops if applied to soils deficient in decaying organic matter, but if applied in intimate connection with rotting manure it is thus made soluble and available for plant growth.

Certainly one of the most profitable, and probably the most profitable, method of maintaining the necessary supply of phosphorus in the soil is to put back into the manure in the form of fine-ground raw rock phosphate somewhat larger amounts of phosphorus than the animal has retained in his bones. It is well for a time at least to put back larger amounts than the animals retain, because the soils are already deficient in phosphorus and also because there may be some waste of manure.

These statements are based both upon the chemical analysis of soils and crops and manures and also upon carefully conducted field experiments covering many years. Several experiment stations have furnished some valuable data from phosphate investigations, and a large amount of information is rapidly accumulating from our more extensive work in Illinois, but the most complete experiments of long duration are reported by the Ohio Experiment Station. Where 40 pounds of fine-ground rock phosphate, costing about 15 cents, were added to each ton of fresh manure and 8 tons of manure per acre were applied for a three-year rotation of corn, wheat and clover, the value of the increase in crop yields was equal to $3.49 for each ton of manure used, while the manure was worth only $2.33 per ton without the phosphate in case of fresh stall manure and only $1.72 per ton for open yard manure, these results being the average of 11 years' experiments on three different series of plots, based upon increased yields valued at 35 cents a bushel for corn, 70 cents for wheat, and $6 a ton for clover hay. If we deduct the cost of the phosphate used we still have what might be termed a net value of $3.34 a ton for the phosphated stall manure.

Of course it would be equally appropriate, and possibly more so, to speak of "manured phosphate" instead of "phosphated manure," because the rock phosphate actually furnishes the needed and deficient element, phosphorus, while the manure helps to make it available. On this basis we may say that the value of 40 pounds of rock phosphate is increased from 15 cents to $1.16 by mixing with a ton of stall manure, after deducting the value of the untreated manure.

The most important fact to keep in mind, however, is that both the manure and rock phosphate are much more valuable when used together than when used separately, because manure is deficient in phosphorus and rock phosphate does not act satisfactorily except in connection with rotting organic matter. As a rule, it is better to use sufficient rock phosphate with each ton of manure, so as to supply about 200 pounds of rock phosphate per acre for each year in the crop rotation.

It should be emphasized that the element phosphorus is the key to permanent agriculture on our great body of agricultural lands;

and the highest present duty of the people of the United States is to see to it that provision is made whereby our own phosphates, both high grade and low grade, may be applied to these soils, where they will remain until removed in the crops; and where, if the farm manures and all other recoverable residues are returned to the soil, they may be used for the production of crops over and over again.

Exportation of phosphate should cease, gradually if necessary, the exportation being limited to a million tons a year with an annual reduction of a hundred thousand tons, so that none would be exported after ten years. The Federal Government should undoubtedly control so far as necessary the mining and distribution of these phosphates with some limitations upon the profits that may be exacted by the phosphate owner from the agricultural people, in order that farmers and landowners may be encouraged to apply to their lands more phosphorus than is taken out in the crops removed.

FARM TENURE IN THE UNITED STATES

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The census of 1900 reported an area of 841 million acres of land as included within farms; this is about forty-five per cent. of the entire land area of continental United States. The census divides farm lands into two parts: (1), improved or cultivated land; and (2), unimproved land consisting of woodland, permanent pastures, etc. In 1900 the improved land was a trifle less than half of the total farm area, or 415 million acres, which is 21.6 per cent. of the land area of the United States. There were in that year 5,739,-657 farms, having an average area of 146.6 acres each, of which 72.3 acres were improved land. Statistics of agriculture have been gathered with increasing fullness by each census since 1850. Data concerning tenure were first obtained in the census of 1880.

The average number of acres per farm and the average number of acres of improved land are given for each census in the following table:

Census of	Av. acreage per farm.	Av. acreage of improved land per farm.
1850	202.6	78.0
1860	199.2	79.8
1870	153.3	71.0
1880	133.7	71.0
1890	136.5	78.3
1900	146.6	72.3

The average farm decreased in size from 1850 to 1880, and since that time has increased. Whether this recent increase is to continue and whether it has significance, time alone will show.

Viewing the country by geographical sections, the greatest increase in farm area has taken place in the Western section, including the states of the Rocky Mountains and the Pacific Slope, and in the North Central States, including those north of the Ohio River and the south boundary of Missouri and Kansas, and from Ohio westward to include the Dakotas, Nebraska and Kansas. In the north Atlantic section, including New England, New York, New Jersey and Pennsylvania, and the south central section, including the states south of the Ohio River and the south boundary of Missouri and Kansas, and from Kentucky, Tennessee and Alabama westward to include Oklahoma and Texas, the average farm has increased only between 1890 and 1900, while in the south Atlantic section bordering the Atlantic, including the states south of Mason and Dixon's line, with West Virginia, there has been a steady decrease in the size of farms from 1850 to 1900.

The column giving the average number of acres of improved land per farm shows irregularities, with a general decrease from the earliest censuses to the last one. Viewing the country as before, by sections, the north Atlantic and south Atlantic sections show a continuous decrease in area of improved land; the south central section shows a general but not regular decrease; the north central section shows an increase from 1850 to 1900; while the western section shows an increase to 1880, and since that time a decrease.

The 5,739,657 farms in the United States in 1900 were distributed as follows as regards tenure:

Farms operated by	No. of farms.	Percentage of all farms.
Owners	3,149,344	54.9
Part owners	451,515	7.9
Owners and tenants	53,299	0.9
Managers	59,213	1.0
Tenants for cash	752,920	13.1
Tenants on shares	1,273,366	22.2

The first class comprises those farms owned entirely by the occupants; the second, those owned in part by the occupants and in part by some other person or persons from whom they are rented by the occupants; the third, a small class, includes those occupied in part by the owners of the entire farm; the remainder being worked by tenants; while the fourth class comprises farms owned by individuals or corporations and carried on by salaried managers. In earlier censuses all these four classes have been considered as owned farms, and for purposes of comparison they will be grouped together. The last two classes comprise the rented farms; the first for a fixed money rental, the second for a share in the product.

In 1900, tenantry was most common in the southern states, where only fifty-three per cent. of the farms were worked by their owners, the remaining forty-seven per cent. being operated by tenants. It was least common in the western states where only one-sixth were rented. In the northeastern states twenty-one per cent. were rented, and in the north central states twenty-eight per cent. The lowest proportion was in the State of Maine, where fewer than one in twenty farms were worked by tenants, while the highest proportion was in Georgia, where three-fifths of the farms were rented.

Farms carried on by managers were most numerous in the far western states, where this class of farms consists mainly of great cattle or sheep ranches. There is little difference among the different sections of the country in the prevalence of the two kinds of rental, whether for cash or shares.

The foregoing table shows that less than two-thirds, or 64.7 per cent., of all farms were worked by their owners, and that more than one-third, or 35.3 per cent., were operated by tenants. It shows, furthermore, by comparison with similar returns from earlier censuses, that the proportion of tenant farmers has greatly increased. Thus, in 1880, three-fourths, or 74.5 per cent., of all farms were worked by their owners and only one-fourth by tenants.

It must not be hastily assumed, however, that because the number and proportion of rented farms have greatly increased that we are drifting toward a system of landlordism. If owned farms have increased in number as rapidly as has the farming population, or the occupation class of those engaged in agriculture, it would appear that there has occurred no relative diminution of the owning class, and we must look elsewhere for those who have rented the farms.

Out of every 1000 males engaged in agriculture in 1880, 422 owned their farms; in 1900, the corresponding number was 423, or practically the same. Out of the same 1000 persons in 1880, 145 rented their farms, and in 1900 this number had increased to 231. The remainder of the 1000 persons, 433 in 1880 and 346 in 1900, were farm laborers. This class shows a great decrease in the twenty years, and leads to the conclusion that the increase in renters came from the class of farm laborers and not from the owners, and indicates progress and not retrogression, since it is a step upward from laborer to renter.

The total number of males engaged in agricultural pursuits increased twenty-four per cent. in the twenty years between 1880 and 1900. In the same period the total number of farms increased forty-three per cent., showing, as above, by another method, a much greater increase in the number of farms than in persons engaged in farming.

The number of farms worked by their owners increased twenty-four per cent. in the same time, the same proportion as the increase in agricultural workers. In the same period, rented farms increased not less than ninety-nine per cent., or four times as rapidly as the owned farms. Farms rented for cash increased 134 per cent., and those rented on shares eighty-one per cent.

In earlier times when public land suitable for farming could be had for the asking, the farm laborer who wished to better his conditions availed himself of the liberal land laws and secured for himself a homestead from the public lands, becoming at one step a proprietor. In those days there were, in all probability, few rented farms. Now, however, with the public lands available for cultivation without irrigation practically gone, he is obliged to purchase at high prices from private owners, or to lease. In many, perhaps most, cases he is unable to purchase, and therefore leases in the hope of being able to purchase later.

The following table shows the average size of farms and the amount of improved land per farm, under various forms of tenure, and the proportion of the farm which was improved:

	Farm areas.	Improved land.	
	Acres.	Acres.	Percentage.
Average size of all farms	146.6	72	49.3
Wholly owned	134.	69	51.2
Partly owned	277.	126	45.4
Owned and tenanted	172.	102	59.5
Managed	1,514.	189	12.5
Rented for cash	103.	57	55.1
Rented on shares	92.	65	70.3
All classes of ownership	174.	78	44.8
Both classes of rental	96.	62	64.6

The owned farms were much larger than those rented, both as regards total and cultivated area. On the other hand, a larger part of the rented farms was cultivated than of the owned farms. The largest farms were those under managers, and of these the proportion under cultivation was far the least. Of the two classes of rented farms, those rented on shares had a much larger proportion of cultivated land than those rented for cash.

The following table classifies owners and tenants of farms and farm laborers, by age, in percentages of the total of each age group:

Age in years.	Percentage of all in age groups. Owners.	Tenants.	Laborers.
10 to 24	2	6	92
25 to 34	26	32	42
35 to 44	53	30	17
45 to 54	64	27	9
55 to 64	74	19	7
65 plus	81	14	5

Out of every 100 persons under twenty-five years of age engaged in agricultural pursuits, ninety-two were laborers, six were tenants, and only two owned farms. Between twenty-five and thirty-four years, there was a large increase among owners and tenants and a great decrease among laborers. This decrease among laborers continued through all ages, while the proportion of tenants decreased in each age group above thirty-four years. On the other hand, the proportion of owners increased throughout, and was greatest at the most advanced ages.

The following table shows a classification by age of farm owners, tenants and laborers in proportions of the total number of each of these three classes:

Age in years	Percentage of all in classes. Owners.	Tenants.	Laborers.
10 to 24	2	10	71
25 to 34	15	32	18
35 to 44	25	25	6
45 to 54	25	19	3
55 to 64	19	9	1
65 plus	14	5	1

Of all farm laborers, seventy-one per cent. were under twenty-five years of age, and the proportion rapidly diminished with advancing age. Tenants increased up to thirty-four years, and then decreased through all ages. Owners increased up to forty-five years and then decreased slowly.

Both these tables show unmistakably a strong movement with advancing age away from the laboring class to the tenant class, and thence in turn to the owner class.

Rented farms were most numerous among cotton farms, *i. e.*, farms devoted mainly to the culture of this textile; of all rented farms, thirty-six per cent. were cotton farms; hay and grain farms formed twenty-six per cent.; and live stock, sixteen per cent. Of all cotton farms, nearly two-thirds were rented; of hay and grain farms, nearly two-fifths; and of live stock farms, only one-fifth.

The following table shows the average value per farm, under different tenures, of land and buildings and the average value per acre of the land:

	Land.	Buildings.	Land and Buildings.	Land value per acre.
Owners	$2,124	$711	$2,835	$15.84
Part owners	3,627	721	4,348	13.11
Owners and tenants	2,961	855	3,816	17.24
Managers	11,627	2,379	14,006	7.68
Cash tenants	2,099	423	2,522	20.83
Share tenants	1,854	386	2,240	20.05

The greatest value, both of land and buildings, is in the class of managers, due of course to the large area and the corresponding extent of the establishment. The smallest, both as to land and buildings, is in the two tenant classes; the first because the area of the farm is small, and the second because a large proportion of the occupants are colored who require less costly structures.

The following table shows the value of implements and machinery on farms classified by different forms of tenure:

	Average value.		Percentage
	per farm.	per acre.	value of land.
Owners	$139	$1.04	6.6
Part owners	186	0.67	5.1
Owners and tenants	169	0.99	5.7
Managers	788	0.52	6.8
Cash tenants	92	0.89	4.4
Share tenants	89	0.96	4.8

In average value per farm, the cost of implements and machinery was very high in those farms under managers, owing to the large area and value, and lowest in the rented farms owing to their small extent and the race of a large proportion of the occupants.

In value per acre, the class of managers is very small, while the tenant class is not much smaller than the owner class.

In percentage of value of land, the tenant class is smallest, for the reasons before given.

The following table shows for rented farms the percentage which the number of owners of one farm, two farms, etc., bore to the total number of owners, the percentage of the total number of rented farms thus held, and the corresponding percentages of the total acreage and value in each group:

No. of farms.	Percentage of owners.	Percentage of farms.	Percentage of area.	Percentage of value.
1	80.0	52.0	62.3	66.9
2	11.4	14.8	13.7	14.3
3 and 4	5.4	11.6	9.4	8.4
5 to 9	2.3	9.7	7.0	5.2
10 to 19	0.7	6.0	4.2	2.9
20 and over	0.2	5.9	3.4	2.3

In further explanation of this table, eighty per cent. of all owners of rented farms owned only one farm each; fifty-two per cent. of all rented farms were thus owned; the area of these farms was 62.3 per cent. that of all rented farms, and the value 66.9 per cent. of the value of all. Furthermore, 0.2 per cent. of all owners of rented farms owned twenty or more farms each, and collectively they owned 5.9 per cent. of all farms, 3.4 per cent. of the area, and 2.3 per cent. of the value.

This table measures the extent of the concentration of farm lands and values in few hands. While such concentration is apparent, it has not yet made great progress. Those who owned twenty or more farms numbered 3,244, held an average of thirty-five farms each, with an average area of 1,959 acres.

The degree of concentration in the ownership of rented farms is further characterized by the following statements. Fifty-five per cent. of the owners possessed forty-seven per cent. of the farms with only twenty-six per cent. of the area and but ten per cent. of the value; thirty-seven per cent. of the owners had thirty-eight per cent. of the farms, forty-four per cent. of the area, and forty-six per cent. of the value; while eight per cent. of the owners had fifteen per cent. of the farms, thirty per cent. of their area, and no less than forty-four per cent. of their value. Thus the largest and most valuable of these farms were in few hands.

The owners of not less than seventy-five per cent. of the rented farms lived in the county in which the farms were situated; fifteen per cent. lived in the same state, but outside of the county; five per cent. lived outside of the state; and the remaining five per cent. was not reported. Less than 0.1 per cent. lived in foreign countries.

The following table shows for rented farms the percentage which the number of owners of farms, their acreage and value, in each specified class of size of farm bore to the total number, area, and value:

Acreage per farm.	Percentage of owners.	Percentage of farms.	Percentage of area.	Percentage of value.
Under 100	55.3	41.9	16.6	21.9
100-200	26.4	23.7	25.2	30.0
200-500	14.8	20.2	29.0	30.4
500-1000	2.5	7.6	11.3	9.2
1000-2500	0.8	4.6	7.4	5.2
2500 plus	0.2	2.0	10.5	3.3

In interpretation of this table, the rented farms having an area less than 100 acres were owned by 55.3 per cent. of all owners, numbered 41.9 per cent. of all rented farms, had collectively an area of 16.6 per cent., and a value of 21.9 per cent. of all such farms.

The percentages of value were greater than those of area in the smaller farms, and decreased relatively among the larger farms. Thus, whereas among the farms of less than 100 acres the total area was only 16.6 per cent. of all rented farms and the value 21.9 per cent. of the value of all, the farms of 2500 acres and more comprised 10.5 per cent. of all the rented area and only 3.3 per cent. of all the rented value.

From this table it will be seen that one per cent. of the owners possessed 6.6 per cent. of the farms, 17.9 per cent. of the area, and 8.5 per cent. of the value.

The following table shows for rented farms the percentage which the number of owners, of farms, their acreage and value, in each specified class of value, bore to the total number, area and value:

Value per farm.	Percentage of owners.	Percentage of farms.	Percentage of area.	Percentage of value
Under $1,000	38.8	30.9	13.5	4.4
$1,000-$2,000	15.8	15.6	11.9	6.0
$2,000-$5,000	24.1	23.8	24.6	21.5
$5,000-$10,000	13.2	14.5	19.8	24.3
$10,000-$25,000	6.9	10.3	17.1	26.4
$25,000 plus	1.2	4.9	13.1	17.4

The rented farms valued at less than $1000 were owned by 38.8 per cent. of all owners of rented farms, were in number 30.9 per cent. of all, comprised 13.5 per cent. of the area of all such farms, and had 4.4 per cent. of their value.

From the above table it appears that 8.1 per cent. of the owners held 15.2 per cent. of the farms, 30.2 per cent. of the area, and 43.8 per cent. of the value; and further, that 1.2 per cent. of the owners held 4.9 per cent. of the farms, 13.1 per cent of the area, and 17.4 per cent. of the value.

Farms occupied by white farmers were 86.6 per cent. of all farms; those of negro farmers were 13.0 per cent.; the small remainder, 0.4 per cent., representing those of Indians, with a few Chinese and Japanese.

Of the white occupants, 70.5 per cent. were owners, 9.6 per cent. were lessees for cash, and 19.9 per cent. were lessees for shares in the product.

Of the colored occupants, only 25.4 per cent. were owners, while 36.6 per cent. were lessees for cash, and 38.0 lessees for shares in the product.

Thus the proportion of rented farms to all farms differs widely between the two races—29.5 per cent. for whites and not less than 74.6 per cent. for the colored.

Of all farms operated by colored farmers, 96.5 per cent. were in the states lying south of Mason and Dixon's line, the Ohio River, and the south boundary of Missouri and Kansas, and from the Atlantic westward to Texas. The further discussion on tenure and race will be confined to this area.

In the South in 1900 there were 2,620,391 farms, of which 1,879,721, or 71.7 per cent., were occupied by whites, and 740,670, or 28.3 per cent., by colored. The farms occupied by whites had an average area of 172 acres, and those occupied by colored farmers an average area of only fifty-two acres. Each "white" farm contained fifty-five acres on the average and each "colored" farm thirty-one acres of improved land. Of the entire area in farms, whites occupied 89.3 per cent. and colored occupied 10.7 per cent. Of the entire area of improved land, whites occupied only 81.6 per cent., and colored 18.4 per cent., a proportion much greater than that of farm land.

Of all "white" farms, 63.9 per cent. were owned by the occupants and 36.1 per cent. were rented. Of the "colored" farms, only 25.4 per cent. were owned and 74.6 per cent. were rented, showing very decided differences between the two races. Of all owned farms, 86.4 per cent. were "white" and 13.6 per cent. were "colored." Of all rented farms, 55.1 per cent were "white" and 44.9 per cent. were "colored." The renting of farms was vastly more prevalent among the colored than among the white population of the South.

The following table shows the average area of owned and rented farms and of the improved land of each race:

	Average area in acres.	
Class.	White.	Colored.
All farms	172	52
Owned farms	217	73
Rented farms	92	43

	Average area of improved land in acres.	
Class.	White	Colored
All farms	55	31
Owned farms	61	33
Rented farms	44	31

White farms were in each case much larger than colored, although the disproportion was not as great with improved land in farms as in the total area of farms, showing that with the colored farms the proportion of improved land was greater. The following table measures this and also demonstrates that rented farms were more fully developed than were owned farms:

	Percentage of improved land in farms.	
Class.	White.	Colored.
Owned farms	28.0	44.6
Rented farms	49.2	71.6

Of the total acreage in white farms, 80.6 per cent. was owned and 19.4 per cent. was rented; of the acreage of colored farms, only 36.6 per cent. was owned and 63.4 per cent. rented. Of the total owned acreage, whites had 95.0 per cent., and colored only 5.0 per cent. Of the rented acreage, whites had 72.5 per cent. and colored 27.5 per cent.

Of the total area of improved land owned, whites held 92.3 per cent. and colored 7.7 per cent., the latter somewhat more than their proportion of the total farm acreage. Of the improved land rented, whites held 63.7 per cent. and colored 36.3 per cent. This last is also a larger proportion than of the total farm area.

Of the improved area of white farms, 71.0 per cent. was owned and 29.0 per cent. rented; of the improved area of colored farms, 26.5 per cent. was owned and 73.5 per cent. rented. Thus the proportions for the two races are very nearly reversed.

The average value of the white owned farm was $2381, and of the colored farm only $807; of the white rented farm $1362, and of the colored farm $606. The white owned farm thus had a value nearly three times as great as that of the colored owned farm, and the white rented farm a value more than double that of the colored rented farm. These differences in value, however, are merely a reflex of the difference in area, for in value per acre there is little difference between the farms of the two races. Owned farms, both of white and of colored, were valued at $11 per acre, and rented farms of white and colored at $15 and $14 per acre, respectively.

The value of the product per white owned farm was $656, and of the colored owned farm $381; for white rented farm $461, and for colored rented farm $347, the white farms of the same tenure producing more than the colored, owing to their greater area. The production per acre for white owned farms was $3.02, and for colored owned farms $4.51; for white rented farms $4.98, and for colored rented farms $8.04. These differences are due to the varying proportions of improved land, as shown in the following statement. The product per acre of improved land was for white owned farms $10.79, and for colored owned farms $10.11; for white rented farms $10.42, and for colored rented farms $11.26.

The ratios of production to value of farms varied through quite a wide range. The proportions were, for white owned farms twenty-seven per cent., for colored owned farms forty-one per cent.; for white rented farms thirty-four per cent., and for colored rented farms fifty-seven per cent. The larger the proportion of improved land the larger the percentage of product.

At the close of the Civil War the negro held practically no farm land. In the forty-four years which have elapsed, he has acquired five per cent. of the owned farm land of the South and 7.7 per cent. of the owned improved land, besides renting 27.5 per cent. of the rented farm lands and 36.3 per cent. of the rented improved land. The value of the farms he owns is five per cent. of the value of all owned farms, and the value of those he rents is 27.0 per cent. of the value of all rented farms. The products of his farms are 23.0 per cent. of all agricultural products of this part of the country.

WHAT MAY BE ACCOMPLISHED BY RECLAMATION

By Hon. Frederick H. Newell,
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In the conservation of natural resources reclamation plays a very large part, both directly and indirectly. There is involved in the idea of reclamation not merely the better use of lands otherwise practically valueless, but in connection with this the creation of opportunities for homes; also, but secondary to this, is frequently brought in the storage or disposal of waters in such way as to render possible the use of these waters for power or other industrial purposes, including the manufacture of electricity for lighting, heating and transportation.

The word "reclamation" as now commonly employed involves the conception of regulating the water supply for a given area of land, which, under natural conditions, has an excess or deficiency of moisture so great that agricultural values are nearly or completely destroyed. We speak of reclaiming the swamp or overflowed lands by keeping the waters off them, or of reclaiming arid lands by bringing waters to them at the time and in the quantities best adapted for the development of plants useful to mankind.

The National Government has been and still is an owner of vast areas of reclaimable land. In the early history of the life of the nation, individuals initiated works for draining and reclaiming areas of low-lying but very fertile land. Later, to promote the reclamation of these, Congress passed laws which, in general terms, conveyed to the separate states the title of the swamp and overflowed lands within their borders in order that these lands might be reclaimed by the state through corporate as well as individual activities. The grants were not, however, sufficiently well guarded to secure the desired results, and although practically all of the states eagerly sought and acquired the swamp lands and passed them over to individuals and corporations, very little was ever done to reclaim and utilize these lands. They became objects of speculation, and vast areas still remain in the hands of men who are holding them for rise in prices. The experience of this kind of legislation had strong influence on subsequent debates in Congress on measures to promote the reclamation of arid lands. The failure of the states to secure reclamation of the swamp lands was a very powerful argument against giving the arid lands to the states in which they were situated, although very convincing pleas were advanced why this work should be confided to the state officials.

There remains yet to be worked out some feasible scheme by which the vast areas of swamp and overflowed lands whose title is now in private ownership may be reclaimed, subdivided, and put in the hands of men who will cultivate them. The soil of these swamp lands is extremely fertile and with effective systems of drainage the lands are capable not merely of supporting large and prosperous agricultural communities, but will be sources of strength to each commonwealth in which they are situated, instead of being, as now, breeding places of mosquitoes and other pests, centers of disease and a menace to land values in the neighborhood.

It may be possible after diffusing information and stimulating public interest to bring together the diverse interests and ultimately to reclaim the large tracts of the swamp land donated to the states, but this can come about on a broad scale only after careful study of the entire situation and the adoption of far-reaching plans. It is, of course, possible to take up one particular tract and build levees, dikes and drains, but it frequently happens that the plans made for one area are such as seriously to interfere with the development of another or more important piece of land; or the system proposed for several areas may be such as not to provide adequate waterways for tracts higher up, and thus disaster may follow the carrying out of schemes which are not sufficiently broad to take in all the surrounding conditions. Where, on the contrary, plans for reclamation start with a full knowledge of all the conditions as they exist and a comprehension of ideal results to be attained, it should result that with the execution of these plans, great tracts of fertile but water-clogged soil will be made available for agriculture.

The term "reclamation" has of late been popularly used with a somewhat restricted meaning, as applying to the irrigation of arid lands and the bringing on of a needed amount of water at proper seasons. Reclamation in this sense has been undertaken by the National Government under the terms of an act passed June 17, 1902, which creates a special fund in the treasury out of the proceeds of the disposal of public lands. This fund is entirely distinct from the general revenues of the Government, derived by imposts or taxation, and hence it is not subject to many of the constitutional limitations which are imposed upon acts of Congress. The expenditure of the reclamation fund has been placed by Congress in the hands of the Secretary of the Interior for the purpose of making surveys and examinations and later constructing feasible projects for the reclamation by irrigation of arid and semi-arid lands. He is also charged with the duty of maintaining and operating these projects until the charges for water for the major portions of the land have been repaid, when the burden of operation and maintenance passes to the owners of the lands.

The Reclamation Act is very general in character and imposes large discretion upon the secretary. In order to carry it out, he has organized what is known as the Reclamation Service, which is practically a bureau of the Department of the Interior. This service consists of men selected through competitive civil service examinations, based largely on practical experience, and who have made a record for efficiency each in his specialty. This organization has been in existence for a little over six years, and during that time, under the direction of the Secretary of the Interior, has made plans for many important works, and has erected a number of these, the estimated expenditures being in round numbers fifty millions of dollars. Already nearly a million acres have been placed under irrigation, and a third of this has been actually watered. Large dams and other structures for conserving water have been built, so that additional areas can be brought under irrigation by completing other units.

The building of large structures for water conservation and for the reclamation of land is not, however, the ultimate object. These works in themselves are notable, but their importance to the nation comes from the fact that they make possible opportunities for the creation of small farms and building of homes for an independent citizenship. The question of prime interest to the general public is not so much that of how far these works may be extended, but what may be accomplished through them by the reclamation of lands otherwise valueless.

Throughout an extent of land, equalling fully two-fifths of the area of the entire United States, there is not enough rain, at least in the crop season, for the needs of useful plants, and for success in agriculture there must be a constant supply of water, artificially controlled and brought to the fields. Between the two extremes—on the east a humid region with occasional summer droughts, and on the west a truly arid region where all plants need irrigation—lies a broad and somewhat debatable belt of land known as sub-humid or semi-arid region, within which irrigation is valuable, but where the need is not so pressing as to render the practice always successful. In the arid region there is no question as to what may be accomplished by reclamation. The extent of the accomplishments are bounded simply by available water supply, and the acreage which will be reclaimed in the future can be given accurately when facts become available as to the quantity of water which may be stored or pumped to the dry lands.

In the semi-arid region, however, the question is a little more complicated, as the extent to which irrigation may be extended in the future is modified by the possibilities of finding useful drought-resisting plants which can be cultivated on the rich soil where the water supply is now somewhat deficient. Our present knowledge of the water supply available for use in both the arid and semi-arid regions is not sufficient to state accurately the limits which are set by nature to the irrigable areas.

There is more good land in the arid region than there is water for it. If all the run-off waters of this region could be conserved and employed in irrigation, the total reclaimed area might, perhaps, be brought to nearly 60,000,000 acres. This is uncertain, however, as our data on run-off are confined to a portion only of the streams, and are incomplete even for these; furthermore, such an estimate involves assumptions regarding the duty of water that may introduce large errors; that is to say, we do not know in all cases how much land can be irrigated by a given amount of water. It is known, moreover, that large portions of the water of the arid region can not be used in irrigation, as no irrigable land exists upon which it can be brought at feasible cost.

In general it may be stated that the value of irrigated land is increasing while improvements in machinery are tending to decrease costs of construction of reclamation works, so that it is impossible to draw an exact line between the probable and improbable schemes, even if we had full knowledge regarding present costs. This would require elaborate surveys, which have not been made. For these reasons any present estimate of the total irrigable area is necessarily little better than a guess. With present data, the closest statement is probably under 60,000,000 acres and between 40,000,000 and 50,000,000 acres, including the lands now under ditch.

The subjects of irrigation, forestry, power, domestic water supply, drainage and navigation are all closely interrelated and should be thoroughly studied together, not only in the arid, but in the humid regions. No one of these questions can be properly treated without full regard to all the others. Proper study of these comprehensive subjects should include more extended observations of rainfall and evaporation, especially in high altitudes, and of the annual flow of all streams. Topographic maps should be made showing the areas of drainage basin, the location of reservoir sites, and their relation in altitude and location to irrigable lands and to power and navigation resources. Such maps are the basic information most urgently needed for all land classification, and without them no wise policy can be adopted.

Both state and national laws are incomplete in permitting and encouraging settlement on lands which should be reserved for reservoir sites. Thorough surveys should be made and all feasible reservoir sites, when discovered, should be reserved for development.

The present laws in some states tend to promote irrigation, but in others they do not. The most primitive form of the regulation of water in irrigation is best exemplified by the present laws of the State of California. These declare the principles of priority and beneficial use, and provide that claims to the use of water shall be recorded in the form of a notice of appropriation, and shall be perfected by application to a beneficial use. At the same time they try to recognize as concurrent on the same stream, rights derived by prior appropriation and rights depending on riparian ownership. The riparian doctrine of water rights should be definitely and permanently abrogated in all arid regions. This has been done in some states by constitutional provision and in some by judicial decision. In all the states of the arid region where the riparian doctrine is recognized material modifications in the old common-law doctrine have been made and put into effect.

The progress of reclamation in many of the western states will be extremely slow until better laws are passed covering some of the important points above indicated. The uncertainties concerning rights to water are so great that no one would be justified in incurring large expenditures without better safeguards. The conditions are very much as though we had no system for describing or recording land titles, and every man could claim all of the land he desired, leaving it to the courts from time to time to determine how much land was actually used by each man. The litigation which results from this indefinite condition is endless, since it frequently determines only the relative rights of two men and leaves out of account the rights of third parties or of the public. The confusion which now exists with reference to water titles is indescribable, excepting in those states where a definite system of measuring and recording the amount of water has been adopted.

With larger knowledge of the subject, with better laws, and with skill in handling water, it will be possible to reclaim the vast areas above mentioned, and to make opportunities for at least a million farms and homes, supporting directly five millions of people, and indirectly enabling an equal or greater number of people to be supported through the transportation and manufacturing business which grows up incidental to farming. The yield per acre of the reclaimed land is so great that when completely utilized it is possible that it will support, directly or indirectly, a population averaging very nearly one to the acre. This means communities nearly independent of the effect of fluctuating trade conditions, or of wet or dry weather, and a people more nearly self-supporting than any other similar number in the country. It means a citizenship attached to the soil and with the incentives to the highest patriotism.

THE LEGAL PROBLEMS OF RECLAMATION OF LANDS BY MEANS OF IRRIGATION

By Morris Bien,
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Although irrigation, as applied to the individual dealing with his land, is new to the Anglo-Saxon race, it must have been an early form of agriculture. The earliest traces of civilization are in the arid region of Asia, where men found that, except in a few favored localities, it was impossible to raise crops without applying water to the land. Accordingly, we find in Asia evidences of irrigation work done at an early period and involving great labor and some degree of engineering skill. In Egypt, likewise, there are indications of massive work requiring an enormous amount of labor and the transportation of great quantities of material for long distances. The earliest records contain references to irrigation and the laws of the remotest times of which we have knowledge allude to irrigation matters and regulate various features of irrigation practice.

The Anglo-Saxon race first encountered the subject of irrigation from an administrative standpoint in India; and the enormous development of irrigation works in recent years in that country is a monument to the energy of the British nation. So also in Egypt the British Government has taken hold of the irrigation question and has added wonderfully to the possibilities of development in that country.

In Europe irrigation was introduced in the early stages of civilization, and when the discoverers reached the continent of America they found evidences that irrigation had been practiced for many generations. In the southwestern part of the United States there are ruins of ancient irrigation works and some of their sites are being used for the modern construction carried on under the auspices of the United States Reclamation Service.

The gold miners of California were early confronted with the problem of determining the right to the use of water, because the gold mining involved the large use of streams of water under heavy pressure to break down the hillsides and carry the dirt away into sluices where the particles of gold were deposited and afterwards collected. The right to the use of the water became an important matter and the expense of carrying the water from the streams to the place of use soon made it necessary for the mining population to adopt a set of rules to regulate the rights of those who used the water. These rules were early embodied in the laws of the state of California, and soon became the subject of litigation in the courts.

Not many years passed before the regulation of water appeared in Federal legislation. Gradually, with the development of the West, the water question became of importance in each section of the country. Usually the mining interests were the main ones to be protected, but before long the interests of agriculture became of sufficient importance to require some form of legislation in order to provide for the use of water upon lands for raising crops.

The legislation of California, although not well adapted to modern needs, being the earliest, naturally was the model for the other states and territories. The first great departure from the form of the California statutes is found in the legislation of Colorado. This system was for many years considered to solve the problem, but with the large development of rights and with the complexity introduced by the use of water to such a great extent as to leave but little or no excess, the difficulties to be overcome were increased, and we find in the legislation of the state of Wyoming, adopted in the year 1880, a development of legislation towards the form now regarded as the best practice.

THE LEGAL PROBLEMS INVOLVED

Land Problem

The legal questions arising in connection with irrigation involve problems both of land and of water. The application of water to land for the raising of crops soon developed the need for more care in agriculture and soil cultivation. The cost of securing the water and putting it upon the land makes it evident that the water must be used effectively in order to secure profit from the great expenditures involved. The realization of this idea encouraged the more intensive forms of cultivation. With intensive cultivation it soon becomes manifest that a small tract of land is sufficient for the support of a family, and that the cultivation of large areas under one ownership by irrigation is a form of monopoly not in the public interest and not to be tolerated any longer than is absolutely necessary. In irrigated countries experience shows that the large irrigated farm is difficult to handle and that the interest of the public is greatly promoted by small holdings sufficient for the support of single families.

Fortunately this situation has not required legislation in order to secure a proper distribution of the lands among those who can themselves use and get the benefit of them. The normal conditions are such that it is usually impracticable to practice irrigation on a large scale on a single farm. The problems of labor on a great farm in the more sparsely settled parts of the country are insuperable. In order to handle an irrigated crop a large amount of labor is required, especially in the case of products of great value, such as berries, small fruits, orchard fruits, hops, etc.

The subdivision of holdings in irrigated countries is a problem which seems to settle itself without the intervention of law and without requiring intervention on the part of the people. Statistics have been gathered in a number of cases in order to show the effect of natural processes upon the subdivision of irrigated lands into small holdings. In a small irrigation community in the vicinity of Oakley, Idaho, an investigation made in 1904 showed that in a tract of about 8500 acres the average size of the irrigated farm had decreased from 141.5 acres to 60.4 acres in a period of fourteen years.

Water Problem

The problem of the water supply is one that has confronted humanity from the earliest times. The difficulty is to guard against monopoly. The Anglo-Saxon carried with him to the arid West the riparian doctrine of the English common law as brought to the eastern part of our country from England. Riparian rights as understood under the old common law were that each individual who owned land along a stream was entitled to have that stream pass by his land without impairment in quality or quantity on account of any use by those living above. Manifestly it was impossible to maintain this principle in a country where the artificial application of water to land was necessary in order to raise crops. It became necessary both to adopt a rule that the right to water for irrigation should depend upon actual use, and to modify the common law so as to protect the persons who first used water for irrigation purposes as against those who might desire to take water from the same source of supply at a later date; in other words, to protect the prior appropriator of the water against the subsequent appropriator.

The forms of legislation which arose from the earlier practice, and which were adopted because most suitable, provided that notice of a man's claim should be given to all parties interested by posting some evidence of it at the point of diversion from the stream. The legislation first adopted in California provided that the right to the use of water should be evidenced by a notice of appropriation posted at the place of diversion from the stream and that a copy of this notice should be filed in the county records within sixty days. It was natural that the amount of water claimed should be as large as possible, and the practice for many years was to limit the amount of water claimed only by the imagination of the person filing the notice. This continues to be the rule in those few states where this ancient plan remains in force.

In many cases the notices filed, appropriate many times the maximum flow of streams even in flood stages. In fact, many judicial decisions can be found among the earlier cases, and even within recent times, in which the court has solemnly decreed to each of several individuals a right to take from a stream an amount of water far in excess of that which the stream ever carried, and adjudging to one or more of the parties the right to take from the stream more water than could possibly flow in the stream.

Beneficial Use

To meet the tendency to monopolize the water supply the laws of the states and the decisions of the courts early recognized the fact that the right to the use of water must depend upon beneficial use. Consequently there is a series of laws and decisions attempting to establish this basis; and many cases might be cited of attempts to control the water supply for future use by some form of seeming compliance with the law.

One case is found in the decisions of the California courts where a man diverted water from a stream and used a part of the water for the irrigation of his lands and for the raising of crops. He appreciated the value of the water and accordingly took steps to secure for future use the water he might need for the rest of his land, turning the excess water supply on land which he did not then wish to cultivate. His idea was to lay a basis for proving that he had turned the water upon this land and thus claim a priority of use for this surplus water. The court held, however, that this was not a beneficial use and that a subsequent appropriator of water from the same stream who had put the water to use for the raising of crops had a better right to this excess water, and, therefore, his efforts to preserve a right to this water without actual beneficial use very properly resulted in failure. The records of the courts are full of efforts made by parties who posted or filed notices of appropriation and who, in order to preserve them, carried on a perfunctory compliance with the law. When the test finally came, these men strained every effort to preserve the right which they claimed under this seeming compliance with the law.

The law requires that the work of construction shall be commenced promptly after the claim to water is initiated and shall be carried diligently to completion. It is a common thing to find that after the notice of claim has been posted the claimant will do a small amount of work at or near the point of diversion and perhaps keep one or two men at work at odd times for several months or even years, hoping in this way to be able to substantiate a claim of prompt beginning of construction and diligent prosecution to completion. He hopes at some future time, when trying to defend his rights against some appropriator of a subsequent date to be able to show that he had complied with the law although for a long period he had practically accomplished nothing toward putting the water to a beneficial use.

The legislatures and the courts have recognized this feature of the problem and it has practically always been the settled doctrine in the irrigation legislation of this country that no one could obtain an ownership in the water itself, but that at most he could acquire a right to the use of the water and that the control and regulation of this right must be in the public. Accordingly we find that the legislatures and the courts in all their dealings with these problems have undertaken to see that the water shall be so used as to produce the greatest benefit for the entire community.

The problem has been attacked in many different ways. The laws and the decisions of the courts have developed the principle announced in the reclamation act, enacted by Congress and approved June 17, 1902, that "beneficial use shall be the basis, the measure and the limit of the right." It has been pointed out that this statement is not exactly accurate, because as every one must admit, the basis of the right to the use of water is the ownership or occupancy of land, while the measure of the right and its limit must be beneficial use. In some state legislation there is an attempt to fix an absolute limit to the right to water for beneficial use on land by stating the amount which shall be the limit granted for an acre of land. This limit, of course, is stated sufficiently large to include all forms of agriculture and must necessarily allow too great an amount for some crops and is thus rather a rough approximation to the end to be desired. However, it is a rule which is of value to the courts and at the same time permits a general regulation of the matter by fixing a limit beyond which no one can claim a right.

Where the right to the use of water depends upon beneficial use no water can be beneficially used if it is so applied to lands as to be wasted. Accordingly, some states have passed laws to prevent the wasteful use of water and the courts, as a matter of law and to protect the rights of the public, have decided that a man could not be permitted to waste water and that his rights must be diminished to the extent of any wasteful use which may be proven.

Adjudication of Water Rights

Another problem which has arisen from the use of water is that of determining the right of each individual user. The theory of our English common law is that when a man feels himself aggrieved by the action of another he takes the proper steps to have him brought into court, and upon the evidence adduced by each the court decides their respective rights. This proceeding, however, becomes practically impossible for the determination of water rights.

It is manifest that if A and B are in controversy about their rights and the court decides that A has a better right to a particular amount of water for a particular area of land because of his priority of beneficial use over B, we still find ourselves unable to determine what may be the right of C who may, in fact, have a right superior to both. That a court should undertake to determine the rights of A and B and to apportion the waters of a stream between them, disregarding a fact known to both litigants, and perhaps also to the court, that C has a better right to the use of the waters of the stream than either is a situation which, one would think, could not possibly arise among rational beings. Yet we find that this condition existed for many years in many jurisdictions in the West, and does in fact continue to exist in some.

Manifestly, there is only one way in which the rights of several users of water from the same stream can be determined, and that is by bringing them all into court and having them all show their respective claims to the use of water, whereupon their rights may be determined with some knowledge of the amount of water claimed and the amount available for division among them. In some jurisdictions the courts have undertaken to bring all parties involved in a water suit into the court at the same time, but in most cases it has remained for the legislature to take up the question and to provide means for bringing together all parties interested in the use of the waters from some particular stream or stream system. Such a plan must involve many complications, and special means must be adopted to reduce to a minimum the amount of testimony and the expenditures which must devolve upon each individual who is brought into court in order to protect his rights as against all other appropriators on the stream.

The customary method in litigation would be for each person to bring his own witnesses as to all the facts on which he bases his claim; but it would involve interminable duplication and great expense if each claimant introduced evidence to show the basis of his own claim, his priority to each other claimant, and the amount of water which he claimed to be available for all. Especially would this be the case if the representative of each claimant were permitted to cross-examine the witnesses for every other claimant. Therefore, in most of the states the office of state engineer has been established, whose duties require him to gather all the physical data as to water supply, areas of land irrigated, dates of claims, etc., so that these matters of expert measurement or of record may be brought together by a single agency, and there may be an avoidance of the duplication of effort and expense which would be involved if each individual were to bring the same data to the attention of the court.

When these data have been gathered by the state engineer, he is required in some jurisdictions to digest them and deduce from the facts so gathered the respective rights of the parties, and in fact to make a preliminary determination of the rights of all parties concerned. The parties whose interests are involved are then permitted to appeal from the decisions of the state engineer to the court so that the same question may be tried by the judicial tribunal and determined in the usual way by the court. Where the amount of water available is sufficient for the needs of all parties concerned, there would usually be very little ground for objection to the decision of the state engineer; and in the sections where there is no scarcity of water, this method of adjudication works satisfactorily.

In order to secure the full benefit of these adjudications whether by state engineer, or by the courts, steps must be taken to regulate and control further appropriations of water. The legislature, therefore, provides that no one may acquire a right to the use of water from a stream except by making application to the state engineer, who must examine the petition and determine whether there is unappropriated water available for the use of the applicant. If he finds that there is no unappropriated water available, he rejects the application and the applicant is permitted to appeal to the court if he desires, and have the question judicially determined. Such legislation as this will prevent the unfortunate condition which has arisen in many states where the claims of record are greatly in excess of the actual water available and where the mere fact that a claim to the use of water is of record has been used to float enterprises causing great money loss to innocent investors because the rights claimed do not in fact exist.

Water Appurtenant to Land

The rule that the right to the use of water depends upon beneficial use has necessarily evolved another principle—namely, that the right to the use of water once established for a particular tract of land must remain attached to it; or, to use the legal term, the right to the use of the water is appurtenant to that particular tract.

It would be immaterial to B if A, who has a right superior to his, should use his water upon one particular tract, or upon another, unless A's change from one tract to another should affect the amount of water which B could obtain under his junior right. B's right in such a case would be affected in several different ways: A change in the use of the water from one point to another might involve also the use of a larger quantity of water in order to secure the proper cultivation of the land. This naturally arises from the different characteristics of different soils. The most important need for making the water appurtenant to a particular tract of land arises from the fact that the use of water upon lands usually results in the return to the stream of a large amount of the water so used.

In applying water to lands for the cultivation of crops we may regard the body of the water as disposed of in four different ways: (1) a considerable amount evaporates directly from the earth into the air; (2) of the portion which percolates into the ground a certain amount is taken up by the vegetation and incorporated into the plant life; (3) a certain amount passes away, percolating through the soil and finally reaching some water course; (4) the remainder sinks into the soil for an indefinite distance, and we are not able to state what becomes of it.

In nearly all cases a large proportion of the water returns to the water course. This seepage or return water naturally reinforces the amount of water available for the appropriators lower down upon the stream, and to deprive the lower appropriator of this return water may mean to him the loss of all or a great part of the water to which he is entitled. A change in the place of use could materially affect the amount of return water available for the appropriators lower down upon the stream, who may be either prior or subsequent to the other in right.

There are other ways in which a change in the place of use would affect the water supply in the stream. It might cause the water to return to the stream at a different season than it would return from the other tract of land, due to the different characteristics of the soil as to permeability.

The doctrine of appurtenance must be maintained to secure, as nearly as possible, a continuance of the condition upon which the appropriators from the stream lower down depend for the fulfillment of their own rights. In other words, the stream is to be maintained as nearly as possible in the condition in which each successive appropriator found it at the time of initiating his right.

Doctrine of Appropriation and Riparian Rights

The doctrine of appropriation of water for beneficial use and the doctrine of riparian rights are largely, if not entirely, antagonistic. Nevertheless, the conservatism of legislatures and courts has caused California and other states to try to maintain the doctrine of appropriation and of riparian rights in the same vicinity and in fact upon the same stream. This has happened because in California and Washington, and also in some of the states along the eastern edge of the arid region, a considerable area is sufficiently humid not to require irrigation for the practical production of crops. The riparian doctrine being older and being the one recognized by the common law from which the statute law of the country has been developed, was recognized as superior to the needs developed in the arid section of the states. In the beginning, the arid section was of small importance; its needs have impressed themselves upon the legislatures and the courts only as the result of an increase in population and an increase in importance arising from gradual development.

The problem must, of course, be met in each state, and must be worked out in its own way. The experience of the state of Nevada is perhaps interesting, as showing the manner in which these matters are often worked out. In 1866 the Supreme Court of the State of California decided the well-known case of Lux *vs.* Haggin, in which the court recognized the rights of the riparian owner as superior to the rights of an appropriator, based upon subsequent ownership of land though earlier in use of water. The Supreme Court of the State of Nevada, in 1872, in the case of Vansickle *vs.* Haines adopted the doctrine laid down in this case, and it was the law of the state for some thirteen years. Finally, however, the conflict was presented to the court in a different form, in the case of Jones *vs.* Adams, decided in 1885, and a careful review was given to the entire question. As a result the Supreme Court of the State of Nevada decided that the doctrine based upon riparian rights was not in any manner applicable in that state; that it was entirely unsuited to the conditions existing in that state, and therefore never was and never could be the law for that jurisdiction. The court accordingly reversed itself and overruled the former decision.

In some of the other states, where large areas of the states are humid or semi-arid and where the importance of irrigation has not been felt until recent years, the courts have attempted to apply the doctrine of riparian ownership to the arid sections of the states, involving necessarily a number of important modifications in the original conceptions arising from that principle. These were carried along by the courts from year to year until finally the importance of the irrigation interests demanded a careful study of the situation and an attempt to apply the law in such a manner as to foster the development of irrigation. The riparian doctrine was then thoroughly scrutinized and its inapplicability to the conditions of the state is so fully recognized that the courts find it necessary to get away from the former doctrine and to adopt the principles demanded by the development of the arid section of the state.

This progress in legal interpretation must, necessarily, be based upon the principle that no system of law shall be applied in any country where the results are such as to prohibit or interfere with the development of civilization. We, therefore, find the State Supreme Court of Oregon, in a recent case known as Hough *vs.* Porter, deciding that the riparian doctrine of water rights is not applicable in that state, for in a large part of its area water is necessary for the proper cultivation of agricultural crops.

In some of the other states, where the doctrine of riparian rights is still recognized as effective in sections where irrigation is necessary for the production of crops, there has been greater or less modification in the principles applied. There is no doubt that ultimately, as the irrigation interests assume greater importance, the courts must necessarily recognize the fact that the law must not stand in the way of necessities of the community, and that the court must find one means or another so to modify their rulings as to foster the natural line of development upon which the community must depend.

Water for Electric Power

The reclamation act was not drawn by any one individual, but was the result of the labors of many persons both in and out of Congress who were familiar with the conditions of the arid region. The act, therefore, embodies the two general principles to which reference has been made, viz., that beneficial use is the basis, measure and limit of the right to the use of water, and that the right to the use of water is appurtenant to the land irrigated thereby. The act applies to the use of all methods of applying water to lands, provides for raising water to high levels by means of pumping, and also incidentally recognizes the use of electric power for such purpose.

In connection with many irrigation projects, the opportunity to develop electric power by means of water has made it practicable to extend greatly the area which can be irrigated. On the other hand, the diversion of the water from the stream, or the storage of water, has created opportunities to develop electric power not needed for irrigation purposes. Whenever it is possible to develop electric power in connection with, but not needed for, the irrigation of land, this power should be used for commercial purposes. Such surplus power will be of great value in aiding the development of the community. Aside from its availability for domestic and agricultural operations on the farm itself, it will be useful in connection with factories depending directly upon agriculture, such as beet-sugar factories and canneries. In many communities there may be opportunities for miscellaneous manufactures which will be established wherever a surplus power opportunity is available.

Electric power furnishes an opportunity for the cheap transportation of passengers and freight, and is a great factor in bringing the individual farmers in closer contact with each other, with other farming communities and with the cities. It is thus a very important element in the improvement of the conditions of human life, both in the city and in the country.

This use of the water for the development of electric power in connection with an irrigation system should not, however, be allowed for commercial purposes independent of irrigation. It is, therefore, essential that the use of water for developing electric power must be under the control of the same agency that has supervision over the irrigation enterprise. This gives rise to another problem in connection with reclamation, and that is the control of the relations between the hydraulic development of electric power for commercial purposes and the utilization of the water supply for irrigation.

The necessities of electrical power for commercial purposes are such that it can be used to advantage only in those cases where a certain amount of power can be depended upon throughout the entire year. This, of course, is not always possible in connection with the use of water for irrigation; because the water supply for irrigation, which is drawn upon only during the growing season of the year, must be stored and not allowed to pass down the stream in the non-irrigation season. The state laws and the decisions of the courts should recognize the relative necessities of the community for irrigation and for power, and the laws should permit of such adjustments of the use of water for the two purposes as will best serve the needs of the community.

In this connection it may be stated as a general proposition that the power possibilities when existing below the points of diversion for irrigation purposes are likely to interfere seriously with the use of the water for irrigation, because it is necessary to let the water supply pass down the stream to be utilized by the power plant instead of diverting this water for irrigation purposes. On the other hand, when the water power is developed at a point above the place where it is used for irrigation, it will often be an aid in the irrigation use of water, as the needs for power require a regulated stream, and thus the low water supply is increased by the water held over from the high-water periods, which are usually in the non-irrigation season.

The devolopment of hydro-electric power presents an excellent opportunity for monopoly, and much has been accomplished in this direction by some large corporations that have taken advantage of the lack of regulation to secure enormously valuable rights at little or no expense. The State of Oregon has, by recent statute, taken the lead in the regulation of the use of water for power purposes by providing that the right shall be subject to a nominal charge, that it shall run only forty years and be subject to renewal under such conditions as the legislature may prescribe.

Much yet remains to be done to solve the problems connected with the reclamation of lands and the use of water for irrigation and power, but the general attitude of the communities of the arid region promises steady progress toward a wise solution of these complex questions.

PART FOUR

Minerals: Their Waste and Preservation

OUR MINERAL RESOURCES

BY HON. GEORGE OTIS SMITH,

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PRODUCTION AND WASTE OF MINERAL RESOURCES AND THEIR BEARING ON CONSERVATION

BY J. A. HOLMES,

CHIEF, TECHNOLOGIC BRANCH, U. S. GEOLOGICAL SURVEY; MEMBER OF NATIONAL CONSERVATION COMMISSION, WASHINGTON, D. C.

PRESERVATION OF THE PHOSPHATES AND THE CONSERVATION OF THE SOIL

BY CHARLES RICHARD VAN HISE,

PRESIDENT OF THE UNIVERSITY OF WISCONSIN, MADISON, WIS.

OUR MINERAL RESOURCES

By Hon. George Otis Smith,
Director, United States Geological Survey, Washington, D. C.

Abundance, variety and wide distribution characterize our country's mineral heritage. Large as are the stores of essential minerals, they, however, are not illimitable, and widespread as is their occurrence, nevertheless the most valuable minerals are somewhat unevenly distributed. The recognition of these limiting factors prompts the thorough study of our mineral wealth quantitatively and geographically if we would comprehend the true basis of the nation's industrial life.

An inventory of the mineral resources of the nation recently made public by the National Conservation Commission owes its chief value to the fact that the data used had been in preparation for more than a score of years. The appreciation by Congress of the importance to the nation of its mineral resources led to the establishment of the United States Geological Survey thirty years ago, and this bureau, in its explorations and investigations, had accumulated quantitative data that became readily available at the time of popular awakening to the needs of national conservation.

The distribution of mineral wealth depends on geologic factors, and different geologic provinces are characterized by deposits of different minerals. Herein lies the practical value of much of purely geologic study. Thus, an important part of the Survey's work through these years has been to keep the country informed as to the occurrence of economic minerals.

The facts as to the distribution of mineral wealth are of practical value because of the vital connection between such geographic distribution and the development of manufactures and commerce. Precedence is given to manufactures because this industry rather than commerce should first feel the creative influence of mineral wealth. The metallurgical, clay-working, structural and chemical industries constitute the web and woof of industrial prosperity, and to a large degree it is only the disregard of the principles of political economy that permits the export of raw material beyond the boundaries of state or nation. Free trade among the states of this Union has developed great interstate industries and internal commerce on a grand scale, but this phenomenal national development should not blind the people of the individual states to the advantages of local utilization of their own mineral resources. An illustration of this local utilization is seen in the new industrial South, which is possible because the South has always possessed mineral wealth.

The ten most important mineral products in the United States, in the order of value of annual output, are coal, iron, copper, clay products, petroleum, gold, stone, cement, natural gas and lead. For certain of these minerals the inventory by the Survey presents estimates of the supply with which the nation's needs are to be met. For others, especially clay products and cement, the question of the supply of raw material from which they are produced is of little moment compared with that of the availability of the fuels necessary for the processes of manufacture.

Of nearly equal importance with the factor of abundance of these mineral resources is that of distribution. In the first place, the widespread distribution of the raw material makes possible an industrial nation in which every state and territory has some share in the mineral production. Only three states had a mineral output last year valued at less than a million dollars, and twelve states had a production valued at over fifty million dollars each. Again, no state or section appears to have a monopoly of the mineral industry. While "progressive Pennsylvania," with its total mineral product nearly one-third that of the whole country, leads in coal, cement, stone and natural gas by large margins, another state, Minnesota, leads in iron ore; another, Arizona in copper; another, Ohio in clay products; Oklahoma in petroleum; Colorado in both gold and silver, and Missouri in both lead and zinc. Furthermore, the centers of production are ever shifting. For instance, in 1900 the primacy in quantity of petroleum produced passed from Ohio to California, thence in 1907 to Oklahoma, and within a year, in copper production, Montana had given place to Arizona, in lead Idaho to Missouri, and in silver Montana to Colorado. It is evident that we cannot prophesy the future progress of any industry unless we can determine the centers of the mineral reserves, for it will be toward these centers that industry will trend.

Our country's pre-eminence in supply of mineral fuels constitutes its chief national asset. Coal occurs in all but fourteen states, and the far West and the South rival the East in their stores of petroleum and natural gas. A total area of nearly half a million square miles is underlain by coal beds. This is over sixteen per cent. of the area of the United States, not including Alaska, which has her own coal deposits. Of this area the anthracite coal fields of Pennsylvania, the product of which is of such importance in the eastern markets, constitute less than one-tenth of one per cent.

The tonnage estimates by Mr. M. R. Campbell, the geologist in charge of the Geological Survey field work in mineral fuels, indicate that the country's coal supply is represented by over three million million (3,157,243,000,000) tons. Of this amount nearly one-half (1,474,018,000,000 tons) is accessible and available for mining under present conditions; a third, or approximately one million million (1,153,225,000,000) tons, is accessible only with difficulty and thus represents a reserve that may become available whenever the increased demand warrants the more expensive mining operations necessary for its production. The remaining 530,000,000,000 tons include lower grade sub-bituminous and lignite coals, which, though easily accessible, are not at present in demand.

The tables prepared by Mr. Campbell show that of the coal deposits workable under present conditions, eighty-five per cent. is the higher grade coal, anthracite and bituminous, the remainder being sub-bituminous and lignite. Of the total supply the anthracite and bituminous coal also represent the largest areas, or 250,000 square miles, the sub-bituminous 97,000 square miles and lignite 148,000 square miles. These areas are distributed over six provinces, which rank in order of area as follows: Interior, Northern Great Plains, Rocky Mountain, Gulf, Eastern and Pacific Coast. In order of tonnage, however, the Eastern province, with its fourteen per cent. of area, ranks first, containing over thirty per cent. of the accessible coal, and indeed forty-three per cent. of the available supply, followed by the Northern Great Plains and the Rocky Mountain provinces, then by the Interior province, which if only the higher grades of coal were considered would stand second, the coal in the Northern Great Plains province being largely lignite and that in the Rocky Mountain province to a considerable extent sub-bituminous coal.

If in the consideration of the geographic distribution of the nation's coal reserves a proper correction is applied to the estimated tonnage on account of the difference in heating value of the several varieties of coal, the geographical center of the coal deposits of the United States is at a point in southeastern Nebraska, in latitude forty degrees, twenty-five minutes, longitude ninety-six degrees, fifty-nine minutes.

The world's coal reserve cannot be even approximately estimated. Of the other countries which contribute to the world's production of coal few are believed to possess deposits at all comparable with those of this country. Since the days of von Richthofen's estimate of the coal resources of North China that country has been looked upon as possessing a reserve upon which other nations may draw when the coal supply of Europe and America shall run low. Mr. Bailey Willis' recent estimate on the coal of North China puts the figures at 605 billion tons, with the qualifying statement that this may be a hundred billion tons too much or too little. Such a reserve is fairly comparable with the total amount of coal in the Appalachian coal fields as estimated by Mr. Campbell. In short, the coal fields of Southern, Western and Northern China are sufficient only for the future needs of the great civilization which the Chinese will surely develop.

This glance at the world's reserves of coal shows plainly not only that the United States leads all other countries in production, our annual output being nearly forty per cent. of the total, but also that it possesses the greatest reserves. Yet in respect to no mineral is there greater need to emphasize the folly of exporting the raw material. Let us keep our coal at home and with it manufacture whatever the world needs.

Petroleum and natural gas must be considered together with regard to their distribution. The areas in which they are found are scattered over twenty-two states and aggregate nearly 9000 square miles, in six great petroleum fields. Eighteen states produced petroleum last year and nineteen states produced natural gas. The six known petroleum fields rank as follows in order of reserve: California, Appalachian, Lima-Indiana, Mid-Continent, Illinois and Gulf. Dr. David T. Day, of the United States Geological Survey, estimated the total probable yield of these and minor fields at fifteen to twenty-five billion barrels.

An estimate of the country's reserve of natural gas is much more difficult. Dr. Day has compiled all the data relating to pressure in the various fields, from which he concludes that the duration of high pressure in the known fields is very short. On the other hand, the yield from low pressure wells is persistent and he therefore estimates the probable duration of the supply of natural gas in these words:

"This industrial enterprise of pumping natural gas in order to utilize the entire supply is the most hopeful element in the outlook for a continued supply. It is this feature which made possible the use of a larger quantity of natural gas last year than the year before. The outlook is that natural gas will be utilized for as long a period as has already elapsed since the industry began, with the greater part to be furnished by the Mid-Continent field."

The iron ore supplies of the United States rank second to the coal reserves in national importance. Although iron is one of the most abundant elements in nature, workable deposits of iron ores are not so widely distributed as might be expected. Iron ore is at present produced in only twenty-nine of the forty-eight states and territories, and more than two-thirds of the production comes from two states, Minnesota and Michigan. Dr. C. W. Hayes, the chief geologist of the Survey, in making an inventory of the iron ore supplies, has called attention to the fact that an understanding of the chemical and geologic classification of the iron ores is essential to the appreciation of the limitations and uncertainties of any estimate. In the case of the bedded ores, an approximation can be made comparable with the estimates of coal beds, but on the other hand, in the case of concentration and replacement deposits, the degree of uncertainty in any estimates is much greater.

Dr. Hayes' tonnage estimate of the iron ore deposits available for reduction under present mining and metallurgical conditions is nearly five billion (4,784,930,000) long tons, of which nearly three-quarters is credited to the Lake Superior hematite ores. The Clinton and other ores of the Southeastern district take second rank, the brown ores of the Mississippi Valley third, and the magnetite and Clinton ores of the Northeastern district fourth. Of lower grade ores, which are considered not available under present conditions, it is estimated that there are in the country nearly seventy-five billion tons, of which the largest part again consists of the hematite ores of the Lake Superior region. The relative importance of our country's supplies of iron ore is indicated by comparison with the foreign supplies of iron ore believed to be sufficiently high grade and accessible to render them available for the iron industry of the United States. The total estimate for such deposits in Canada, Newfoundland, Mexico and Cuba is only one and one-half billion long tons, or considerably less than one-half of the available supply in the Lake Superior district alone.

The resources of the United States in the precious metals, as well as in copper, lead and zinc, are much less easily estimated than the supplies of either coal or iron. Although deposits of the precious and base metals are widely but sporadically distributed, occurring in all of the western states and many of the eastern states, yet no large areas are underlain by extensive ore deposits of these metals.

On the basis of investigations by the geologists of the United States Geological Survey, Mr. Waldemar Lindgren states that "to give definite figures representing our metal supply is quite out of the question." In the case of silver, copper and zinc, the reserves are large enough to warrant the expectation that a moderate rate of increase in production can be maintained probably for twenty years or more. In the case of lead, a greatly increased production is regarded as improbable.

Mr. Lindgren believes that the reserves in gold in the United States are great, although only for placer gold is even a rough estimate possible. With continuance of present methods of working and present wages, the placers are estimated to contain one billion dollars of reclaimable gold.

The silver reserves cannot be considered apart from the ores of gold, lead and copper. Over two-thirds of the silver produced in the United States comes from lead and copper ores, and a large proportion of it might properly be regarded as a by-product. From this Mr. Lindgren regards it as "evident that the present supply of silver is assured as long as the mining of lead and copper ores as well as quartzose gold continues on the present scale."

Any attempt to estimate the country's mineral wealth must convince us of the vital importance of utilizing most efficiently these resources, which are so essential to the nation's welfare. In view of the rapidly increasing demand upon these supplies it also becomes imperative that strenuous effort should be made to discover new sources of the mineral fuels and ores. Thus alone can optimism be justified. Only as geologic explorations and mining operations uncover new deposits and block out known reserves can the United States with the continuance of its industrial development avoid facing the sure exhaustion of the supply of certain important minerals within this century.

PRODUCTION AND WASTE OF MINERAL RESOURCES AND THEIR BEARING ON CONSERVATION

By J. A. Holmes,
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The study of the problem of conservation with reference to mineral wealth is easily separable into two divisions, considering under one the mineral resources as they exist to-day, and under the other a study of the production, consumption and waste of these resources and the prevention of this waste. The former of these is discussed in another paper in this volume by the Director of the Geological Survey. In discussing the latter in the following pages but brief consideration can be given to each phase of the subject. The mineral products in the United States for the year 1907 exceeded $2,000,000,000 in value. It is estimated that the waste in the mining and use of these materials is equivalent to more than one-fourth of this amount, exceeding $1,500,000 per day.[1]

The Larger Contributors to Our Mineral Wealth.—The following are a dozen of the largest individual contributions to this $2,000,000,000 addition to the nation's wealth during 1907 in the form of crude mineral products, the values given being those at the mines or works:

Coal, 480,000,000 tons, with a value of	$615,000,000
Iron ore, 52,000,000 long tons, valued at	132,000,000
Pig iron, 26,000,000 long tons, valued at	530,000,000
Copper, 869,000,000 pounds, valued at	174,000,000
Clay products, valued at	159,000,000
Petroleum, 166,000,000 barrels, valued at	120,000,000
Gold, 4,375,000 ounces, valued at	90,000,0000
Stone, valued at	71,000,000
Cement, 52,000,000 barrels, valued at	56,000,000
Natural gas, valued at	53,000,000
Lead, 365,000 tons, valued at	38,700,000
Zinc, nearly 224,000 tons, valued at	26,400,000
Phosphate rock, 2,265,000 tons, valued at	10,650,000

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[1] The statistics of mineral production given in this paper are taken mainly from the reports of The Mineral Resources Division of the U. S. Geological Survey.

The total value of our non-metallic products during 1907 was more than $1,166,000,000. Of this, the fuels (coal, petroleum and natural gas) approximated $788,000,000; structural materials (clay products, stone, cement, lime, slate, etc.), nearly $306,000,000; abrasive materials (grindstones, oil stones, garnet, quartz, feldspar, infusorial earth and tripoli, millstone, corundum and emery), about $1,647,000; chemical materials (phosphate rock, salt, sulphur, gypsum, borax, pyrite, fluorspar, etc.), nearly $30,760,000; pigments (zinc white, mineral paints, barytes, etc.), nearly $9,762,000; and other miscellaneous mineral products (moulding sand, glass sands, mineral waters, asphalt, precious stones, talc, tungsten, feldspar, bauxite, mica, fullers' earth, etc.), about $30,387,000. The total value of the metallic products (iron, copper, gold, lead, silver, zinc, aluminum, quicksilver, tin and platinum) for the same year was $903,000,000. Of this total mineral production in the United States we exported during 1907 mineral products to the value of $347,000,000. This was in part offset by the importation of mineral products to the value of $225,000,000.

The value of mineral products consumed in the United States during 1907 was, therefore, $2,191,000,000, or $122,000,000 in excess of the production.

American Contributions to the World's Mineral Production.—The value of mineral production in the United States as compared to that in other countries is indicated by the fact that during 1907 the United States produced 63 per cent. of the world's petroleum, nearly 55 per cent. of its copper, 52 per cent. of its phosphate rock, 46 per cent. of its steel, 43 per cent. of its cement, 40 per cent. of its iron ore, 40 per cent. of its coal supply, 33 per cent. of its lead, 30 per cent. of its silver, more than 27 per cent. of its zinc, and 22 per cent. of its gold.

Rapid Growth of Our Mineral Production.—There are few better illustrations of the rapid development of this country than the growth of this mineral production. Thus, in 1880, the value of the mineral products in the United States approximated $365,000,000; in 1890, $606,000,000; in 1900, $1,107,000,000; in 1907, $2,069,000,000. The total value of the mineral products for the ten years, 1880 to 1889, inclusive, was $4,478,000,000; that for the ten years 1890 to 1899, inclusive, was approximately $6,594,000,000; whereas that for the eight years from 1900 to 1907, inclusive, was $12,025,-

000,000. If the mineral production for 1908 and 1909 approaches $2,000,000;000 for each year we shall have for the thirty years, beginning with 1880, a total mineral production of approximately $27,000,000,000.

The following table indicates by years the rapid increase in value of the crude mineral products for the United States:

1880	$364,928,298	1890	$606,476,380	1900	$1,107,031,392
1881	400,833,052	1891	605,385,029	1901	1,142,000,029
1882	451,901,159	1892	622,543,381	1902	1,323,102,717
1883	446,859,473	1893	543,693,967	1903	1,491,928,980
1884	406,110,405	1894	549,374,767	1904	1,363,072,345
1885	418,803,180	1895	640,771,528	1905	1,625,135,835
1886	434,137,994	1896	640,544,221	1906	1,904,007,034
1887	508,387,674	1897	646,992,582	1907	2,069,289,196
1888	524,624,536	1898	724,272,854	1908	2,000,000,000[2]
1889	531,293,513	1899	1,014,355,705	1909	2,000,000,000[2]
	$4,487,978,284		$6,594,410,414		$16,025,567,528[2]

As indicated by the figures given above, the estimated value of mineral products for the current decade is nearly two and one-half times that for the preceding decade, and the coal production alone for 1907 exceeded in value the total mineral production for any year prior to 1892. Still more striking are the figures indicating our per capita value of the mineral products, which in 1880 were $7.25; in 1890, $9.68; in 1900, $14.55, and in 1907, $24.19.

Production, Waste and Duration of Fuel Resources.—Unlike the supply of water, which goes and comes perennially, or of farm crops, which annually succeed one another, or even of the forests, which may come in succession with longer intervening periods, the supplies of mineral resources are limited, and they can neither be increased nor reproduced. Our mineral fuels deserve special consideration in this connection for the further reason that their use involves their immediate and complete destruction; and the increase in the manufacture and use of other materials also increases the consumption of fuels for heat, light and power, and for metallurgical purposes. Considerations such as these warrant special attention being given to the fuel problem in any discussion of conservation.

[2] Estimated.

From the beginning of our records of coal mining in the United States, about 1814, to the close of 1907 there were mined nearly 7,000,000,000 tons of coal. During this time the waste in mining probably exceeded 3,500,000,000 tons. The average rate of increase in production from 1846 to the close of 1907 was 7.36 per cent. per annum. The rate of production, however, has been a slightly decreasing one. Taking this and other factors into consideration, the experts of the Geological Survey have estimated that if this growing rate of consumption continues, the easily accessible and available coal supplies, aggregating 1,400,000,000,000 tons, will be exhausted before the middle of the next century. As to whether or how long this increasing rate of production and consumption will continue there may be reasonable differences of opinion. The estimates are based on the experience and development of the nation during the past three-quarters of a century, including its tendency toward an increasing per capita consumption of fuel.[8]

However, the time of this exhaustion will be naturally postponed by virtue of the fact that long before exhaustion would be reached the increasing scarcity and the higher price of fuel would cause a lessening in its rate of consumption. Furthermore, the adoption of more efficient methods in connection with the mining and use of coal, and the larger use of water power and other possible substitutes for coal, may serve to diminish the present increasing rate of consumption and thereby extend the life of the supplies. On the other hand, manufacturing in this country will doubtless long continue to grow more rapidly than the population, and the tendency will be to increase the demand for coal.

The waste of coal, both in mining operations and in use, is far greater than it should be. From the beginning of our mining operations down to the present time the average loss in the mining of bituminous coal has probably exceeded 50 per cent. of the total production. During the last few years, however, both in the anthracite and high-grade bituminous coals, in a number of our Eastern coal fields the loss in mining has been reduced to smaller percentages. In portions of the Central and Western coal regions the percentage of loss still exceeds 50 per cent.

The losses in the use of coal for different purposes cannot be estimated with accuracy, but that these losses are serious is indicated by the fact that in the power plants of the country less than 10 per cent. of the heat value of the coal is converted into actual work, and lighting plants convert less than 1 per cent. of the heat value of the coal into electric light. Large amounts of gas from our blast furnaces are lost by being turned into the atmosphere. To a small but increasing extent, however, these gases are being transformed into power through the use of gas engines. In connection with the coking industry gases and other by-products to the value of more than $55,000,000 were wasted in 1907.

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[8] See also page 210.

Of petroleum the total production during the last half century has exceeded 1,800,000,000 barrels. The rapidly increasing rate at which this production has been obtained and a careful study of the existing known petroleum supplies indicate the probable exhaustion of these known supplies before the middle of the present century. It is probable, however, that the life of the petroleum industry will be largely extended through the discovery of other supplies, as well as through a more efficient use, and, therefore, a lessening in the rate of increase in the demand for existing petroleum products.

The loss or waste of petroleum is proportionately far less than that of most other mineral products. It is unfortunate, however, that so large a proportion of this material which is invaluable for illuminating and lubricating and other specific purposes should be so extensively used as fuel in locomotives, steamships and other power plants. The consumption of petroleum for fuel purposes during 1907 exceeded 35,000,000 barrels.

Concerning the production of natural gas existing records are incomplete. For the twenty years from 1888 to 1907, inclusive, the value of the natural gas recorded was a little more than $493,000,000. The waste of this material has been enormous. The gas wasted has greatly exceeded that which has been used. More care is exercised now than was formerly the case to prevent the waste and provide for the efficient use of natural gas, but it is estimated that even at the present time the daily loss of gas is not less than 1,000,000,000 cubic feet, or equivalent to 143,000 barrels of petroleum, and in one field, the Caddo field of Louisiana, the daily loss of gas is now not less than 70,000,000 cubic feet, enough to light ten cities the size of Washington, and equivalent to a waste of 10,000 barrels of petroleum per day.

Production and Waste of Metallic Resources.—In a brief paper, a discussion of this character may be limited to iron and steel and a few major metals, such as copper, gold, silver, lead and zinc.

The production of iron ore in the United States has increased with a rapidity as striking as that in the case of coal. The production for ten years, from 1870 to 1879, inclusive, was more than 40,000,000 tons. For the ten years 1880 to 1889, inclusive, it was nearly 102,000,000 tons; from 1890 to 1899, inclusive, nearly 184,000,000 tons, and from 1900 to 1909,[4] inclusive, more than 445,000,000 tons. This is an average increase by decades of more than 100 per cent. Even with the enormous supplies of iron ore known to be available for future use, at this increasing rate of consumption these supplies cannot be expected to meet the demands of the nation for an indefinite period. Indeed, it is probable that the supplies of high-grade iron ores will be exhausted and large inroads made on the supplies of lower grade ores before the end of the present century.

The fact that iron and steel, unlike our fuels, are not fully destroyed in use, but accumulate in a measure as one of our national assets, will doubtless in the course of a few generations reduce the present increasing per capita rate of production and consumption of these materials.

Fortunately, there is in the present methods of mining and treatment but little waste in the handling and treatment of the iron ores. Notably, in the Lake Superior districts not only are the high-grade ores gathered with care, but also the ores of lower grade are segregated in such manner as will permit of their easy recovery at such time as their use may become practicable. In some of the other fields the ore waste is greater, but not comparable with prevailing fuel waste, and the losses of iron in modern furnace practice are insignificant. The most serious sources of waste in the supplies of iron and steel are in the losses of the finished metal in use, through wear and through rust and other destructive agencies. These losses are permanent, are increasing and are believed to be largely preventable.

The production of gold increased rapidly from the middle of the last century, but dropped from $60,000,000 in 1852 and 1854 to $30,000,000 in 1883, and subsequently increased to its maximum of more than $94,000,000 in 1906. The production of gold[5] in the United States from 1792 to 1847 was $24,537,000; from 1848 to 1872, $1,204,750,000, and from 1873 to 1907, $1,741,784,000. The total production of gold in the United States from 1792 to and including 1907 was 143,725,839 ounces, valued at $2,971,071,000.

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[4] Production for 1908 and 1909 being estimated.

The important production of silver beginning about 1860 reached its maximum of 63,500,000 ounces in 1892, since which time the average annual production has been about 55,000,000 ounces. The total recorded production of silver[5] in the United States is as follows: From 1792 to 1847, $404,500; from 1848 to 1872, $157,749,900, and from 1873 to and including 1907, $1,351,841,600; a total of 1,730,708,200 ounces valued at $1,509,996,000.

The production of copper has for many years been steadily increasing. It reached its maximum in 1906, when the output was nearly 918,000,000 pounds. Its production may be expected to increase largely in future years, as the uses of copper are increasing both in quantity and variety. The total production from 1860 to and including 1907 was about 12,075,000,000 pounds. Its production by decades illustrates the rapid development of the industry, as follows:

For ten years, 1861-1870, about 218,504,000 pounds.
For ten years, 1871-1880, about 421,120,000 pounds.
For ten years, 1881-1890, about 1,639,231,000 pounds.
For ten years, 1891-1900, about 4,348,713,000 pounds.
For seven years, 1901-1907, about 5,448,000,000 pounds.

The production of lead and zinc during the past thirty years has increased rapidly, reaching a maximum in 1907. The production of lead recorded for 1825 was 1500 short tons. The total production from 1830 to 1907, inclusive, was 6,829,691 short tons. The production by decades since 1830 illustrates the progress of the industry, as follows:

For ten years from 1830 to 1839, inclusive, 122,500 short tons.
For ten years from 1840 to 1849, inclusive, 247,000 short tons.
For ten years from 1850 to 1859, inclusive, 168,800 short tons.
For ten years from 1860 to 1869, inclusive, 153,900 short tons.
For ten years from 1870 to 1879, inclusive, 547,780 short tons.
For ten years from 1880 to 1889, inclusive, 1,345,711 short tons.
For ten years from 1890 to 1899, inclusive, 1,824,657 short tons.
For the 8 years from 1900 to 1907, inclusive, 2,417,843 short tons.

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[5] These figures should be credited to R. W. Raymond for 1792 to 1873, and to the U. S. Geological Survey for subsequent years.

The production of zinc (spelter) in 1873 was 7343 short tons. By 1875 it had reached 15,883 short tons. For the ten years from 1880 to 1889, inclusive, the spelter production was 380,852 short tons; from 1890 to 1899, inclusive, it was 901,591 short tons, and for the eight years from 1900 to 1907, inclusive, it was 1,446,035 short tons. This gives a total production from 1880 to 1907, inclusive, of 2,751,654 short tons.

The waste in the mining and treatment of gold, silver, lead and zinc has diminished as modern practice has grown in efficiency, but in many cases it is still large, in some cases amounting to nearly 50 per cent. of the total possible product. The waste in the treatment of copper is generally less than that for the other of these metals, though the loss in the treatment of certain of the ores of copper exceeds 25 per cent., this being additional to losses in mining. Much of this waste in the mining and treatment of these metals is a temporary waste, the neglected and often buried low-grade ores, as well as the tailings, becoming available for treatment by later and more efficient processes.

Use and Waste of Structural Materials.—The supplies of many of the materials used in building and engineering construction, such as stone, sand, gravel, slate, clays, cement, lime, etc., are practically inexhaustible, and for that reason need not be extensively discussed.

The use of these materials has been restricted heretofore, especially in town and rural building, because of the greater cheapness of timber construction; but owing to improved methods the cost of buildings of concrete and other fire-resisting materials has been diminished, while that of wood products has advanced. Within the last decade the value of cement manufactures increased from $9,900,000 to $55,900,000 for the year, or nearly sixfold, and the value of clay products from $74,500,000 to $159,000,000, or more than double. In the same period the value of building stone increased from $28,600,000 to $71,100,000, or nearly threefold. A still larger relative increase in the use of these more durable building materials may be looked for during the next several decades, since the Government is determining the strength, durability and fire-resistant properties of these materials, and is thus gaining and disseminating information which will serve as a basis of cheaper and more permanent structures.

The waste of minerals used in building and engineering construction comprises (1) that due to improper and wasteful methods of mining or quarrying and preparing for market; (2) that due to the use of excessive quantities of material because of a lack of knowledge concerning strength and durability; and (3) that due to destruction by fire. The losses from the last cause alone during 1907, due to the direct burning of buildings and their contents, were $215,000,000.

Other Mineral Substances.—The scope of the present article does not permit any extended discussion of the production and waste of other less-important mineral substances, of which, as mentioned above under the several classes, some 50 or 60 are produced and used in our industries. However, attention may be called to the fact that of certain of these, such as bauxite, corundum, mica, the ores of manganese, chromium, tin, platinum, antimony, tungsten, etc., the production in the United States is already inadequate for our industrial needs, and the domestic supplies of these materials, even though mined and used with the greatest efficiency, will probably always need to be supplemented or replaced by substitutes or by importations from other countries.

Other materials, such as asphalt, sulphur, magnesite, ochre, borax, talc and arsenic, are found in such quantities that even at the present increasing rates of production the supplies of these materials may be expected to meet the needs of the nation beyond the limits of the present century. There are still other mineral substances, such as clays, fullers' earth, grindstones and other abrasive substances, feldspar, salt, gypsum, etc., of which, notwithstanding their importance and the increasing rate of their production, the domestic supplies may be expected to meet all future demands.

Will the Increase in Mineral Production Continue?—Attention has been called above to the continued increase both in the total mineral production and in the per capita mineral production of the country. It is interesting to note in this connection that there has been a correspondingly marked increase in the per capita consumption of mineral products. The consumption of such products has increased far more rapidly than the population. Thus, in 1880 we used of coal 1.4 tons per capita; in 1890, 2.3 tons; in 1900, 3.2 tons, and in 1907, 4.7 tons.[6] Of pig iron we used in 1880, 200 pounds per capita; in 1890, 320 pounds; in 1900, 391 pounds, and in 1907, 686 pounds. Of copper in 1890 we used 3 pounds per capita; in 1900, 4.6 pounds, and in 1907, 6.4 pounds. Of cement we used in 1890, 70 pounds per capita; in 1900, 92 pounds per capita, and in 1907, 228 pounds per capita.

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[6] Figures for fiscal years, taken from Reports of the U. S. Bureau of Statistics, for both coal and iron.

The population of this country has increased from 5,308,000 in 1800 to 75,569,000 in 1900. After a careful study of the details in connection with this increase and the conditions under which this has come about, and a careful comparison of these conditions with those in the more densely populated countries of Europe where similar resources and climatic conditions maintain, Mr. Henry Gannett, of the United States Geological Survey, has estimated that the population of this country will be in 1910, 90,000,000; in 1950, about 150,000,000, and in the year 2000, approximately, 250,000,000.

In a further study of this question it should be borne in mind that during the past century the energies of the American nation were concerned largely with the conquest of the surface and other agricultural pursuits. Though the mining industry grew rapidly after the middle of the century, for years gold mining was the dominant feature. It was not until within the past quarter century that general mining and the use of mine products in manufacturing industries began to be a serious part of our national life and plans. Thus, for example, as late as 1880 the value of our coal product for that year was a little more than $95,000,000, as compared to gold and silver production of about $71,000,000, whereas in 1907, with a gold and silver production of $128,000,000, our coal production had reached $615,000,000.

If, therefore, in connection with the rapid, realized and prospective increases in our population and the still more rapid increase in our per capita production and consumption of mineral products, we bear in mind the enormous resources of this country in fuels, iron and other essential mineral materials, the genius of our people for industry and the extent to which climatic and other conditions favor manufacturing developments, one cannot fail to realize that this nation is to become more and more a great mining and manufacturing nation; that it must and will develop its varied domestic industries to supply not only its own growing needs, but also the demands of a large and steadily increasing export trade; thus extending and enlarging for generations to come the varied industries in which mineral products are used; and, therefore, that the per capita production and consumption of our mineral products will continue to increase for generations to come even more rapidly than our population. Already the products of the mine make up 65 per cent. of the total freight traffic of the country.

In order that we may be able to supply the raw materials for these increasing industries it will be necessary that we handle wisely our mineral supplies, not only preventing all unnecessary waste, but also practicing the highest possible efficiency in the use of these materials.

Extending the Life of Our Supplies.—The most important phase of the conservation problem is that concerned with the possibility of preventing unnecessary waste and of bringing about the most efficient use of our resources. We need to know how we can extend the life of these resources to meet the future as well as the present needs of the country. Investigation is undoubtedly the most important agency for the accomplishment of this purpose. Much has already been accomplished through this agency. The improvements brought about through the engineering profession during the past half a century in the manufacture of steel and other metallurgical operations and through increased efficiency in the development and operation of power plants, are already saving to the nation more than 100,000,000 tons of fuel per annum. Through the work of the chemist and metallurgist in the improvement of technologic processes used in other metallurgical and manufacturing industries new and more efficient processes have made enormous savings in the resources of the country as well as in the capital required.

Three lines of investigation will prove useful in the continued development of these economies: (*a*) a great number and variety of individual investigations of specific problems by the engineers and chemists in private practice; (*b*) investigations of a more general but also somewhat local character by each of the several states in which are located extensive mining and metallurgical industries; (*c*) investigations by the general government of those problems which on account of their general character may be of service to the mining, metallurgical and manufacturing industries throughout the country.

A number of such investigations by the federal government are already well under way, and are yielding important general results.

Investigations by the states are for the most part limited to the exploration and mapping of local mineral resources. The private or individual investigations relate for the most part to specific individual problems connected with the development of specific local industries, and are intended for individual or private gain alone.

The common purpose of all these investigations must be to indicate (*a*) how we can prevent waste; (*b*) how the mineral products may be mined, treated and used with greatest efficiency; (*c*) how more abundant materials may be substituted for the rarer and more costly materials.

Through careful educational work much also can be accomplished. In this work the federal and state governments are coöperating, as are also, in an effective manner, the engineering and other allied organizations and the educational institutions throughout the country. Through wise legislation, also, much can be accomplished; but unless legislation is wisely planned and administered its influence may be more harmful than beneficial, as it may act in restraint of industry rather than by being helpful to its development.

Conservation and Legislation.—Self-interest will naturally continue to dominate the policies and activities of corporations, and these policies and activities, relating primarily to the question of temporary gain, may not always be in accord with the best interests of the community, the state or the nation. To the state and the nation alone can therefore be intrusted the ultimate guardianship of their own futures; and to this extent, at least, the conservation of resources becomes a state and, in a broader sense, a national duty and right. The United States Supreme Court, in a recent decision, says: "The state as the guardian of the public welfare possesses the constitutional right to insist that its natural advantages shall remain unimpaired by its citizens." And the federal constitution gives to Congress the right "to provide for the common defense and general welfare of the United States."

Any legislation in behalf of the wiser use of our resources should, however, be planned and drafted with care so as to guarantee for its provisions a remedial and beneficial rather than a harmful influence. The lack of uniformity in our state mining laws, even in the case of adjoining states where conditions are similar, is one of the unfortunate developments of our system. The differences have been based, probably, upon the mistaken idea that local mining conditions in different states require different local legislative treatment. As a matter of fact, under modern commercial conditions these differences between state laws may seriously hamper the mining industry in one or another of the states.

It would be helpful to the mining industry in all the states, and helpful to the conservation movement, if mining legislation in the different states could be made measurably uniform in its provisions, leaving for special separate treatment the few really local problems. The benefits which have often resulted from conferences and wise coöperation between individuals or states, and even between nations, would become manifest in legislative as they have in other matters pertaining to the public welfare.

Both in legislation and in public opinion we must maintain as essential a rational basis for the conservation movement which recognizes (1) the right of the individual to property and to reasonable profits on his investments or on his labor, and (2) the paramount rights respectively of the community, of the state and of the nation to safeguard the future as well as the present welfare of its citizens

PRESERVATION OF THE PHOSPHATES AND THE CONSERVATION OF THE SOIL

BY CHARLES RICHARD VAN HISE,
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In a very impressive paper upon *The Natural Wealth of the Land and Its Conservation,* given at the White House at the Conservation Conference, May 13, 1908, Mr. James J. Hill gave a comprehensive picture of the importance of our soil resources, and a severe arraignment of our want of foresight and reckless extravagance which unless checked in the near future threatens to impoverish our nation in its most fundamental asset.

There can be no question as to the correctness of Mr. Hill's position as to the profound importance of the conservation of the soil. Food and clothing, products of the soil, we must have. All of our other wants are subordinate to these.

Mr. Hill says: "Our agricultural lands have been abused in two principal ways: first, by single cropping, and, second, by neglecting fertilization."

In reference to these abuses he says: "The two remedies are as well ascertained as is the evil. Rotation of crops and the use of fertilizers act as tonics upon the soil. We might expand our resources and add billions of dollars to our national wealth by conserving soil resources instead of exhausting them, as we have the forests and the contents of the mines."

Mr. Hill did not mention the first cause for the depletion of the soil, that of soil wastage through erosion; but this aspect of the subject was handled by Professor Chamberlain at the conference. Also McGee and others have painted woeful pictures of the frightful loss of soil by erosion, which has removed the upper part of the soil for a large part of many states and which has even converted extensive areas into bad lands. Therefore, I shall not discuss the dumping of the soil into the sea by the rivers in incredible quantities through cultivation without reference to the conditions necessary to prevent erosion. But it is plain that we must not permit soil erosion to take place more rapidly than the soil is manufactured by the processes of nature. To do so will be ultimately to destroy our soils. If nature manufactures the soil at the rate of one inch in a century, then the erosion must not exceed one inch in one century.

Neither shall I more than mention the question of rotation. One of the chief purposes of rotation is obvious. A crop of one kind draws heavily upon certain elements of the soil. Another does not demand so much of this element. Therefore, it is plain that by rotation of crops the elements of fertility may be drawn upon more slowly and proportionally, and thus, through proper procedure, enable the farmer to retain in the soil an adequate supply of each of the important elements.

The subject to which I wish especially to ask your attention is that of fertilizers. Mr. Hill says: "Fertilizers act as tonics upon the soil." This naturally raises the question as to our resources in these materials. The three plant foods which are most likely to be present in insufficient quantity in the soil and which are most expensive to supply are nitrogen, potassium and phosphorus.

Fortunately, in the atmosphere is an inexhaustible quantity of nitrogen. The problem is to get this free nitrogen into a form in which it can be used by plants. Until comparatively recently this was regarded as almost hopeless, but the discoveries of recent years show that there are two ways in which the nitrogen of the air may be fixed. The leguminous plants, by the aid of bacteria, combine nitrogen in large quantities with other elements and add it to the soil in a form that may be used by non-leguminous plants. By electrical methods, also, nitrogen may be directly combined with other elements. Thus, so far as this element is concerned, the problem is solved. By applying the knowledge which science has furnished us, the soil need never lack the nitrogenous element of plant food.

In the original igneous rocks the average percentage of potassium is about two and one-half. However, there are inexhaustible masses of rock in which the percentage is about three times this average. Therefore the total amount of this element is practically unlimited. By nature's processes potassium has been extensively abstracted from the original rocks and has been concentrated, so that in various parts of the continents there are large quantities of this element in a readily soluble form which are available for fertilizing the soils deficient in it. Even if in the future these segregated and soluble deposits of potassium are exhausted we may still use the original rocks, which are more than ordinarily rich in this element, as a source from which more concentrated material may be manufactured, or the very finely pulverized rocks may be used directly as a fertilizer.

The only remaining element about which we need concern ourselves is phosphorus. This is the element which, so far as we can see at the present time, presents a profoundly serious problem in maintaining the fertility of the soil. Clarke,[1] in his *Data of Geo-Chemistry,* estimates that the crust of the earth contains only .11 of one per cent. of phosphorus, or about .25 of one per cent. of phosphoric oxide. As we have just seen, the average rocks contain twenty times as much potassium. Therefore, looking toward the distant future, if we consider ratios, we may unhesitatingly assert that the problem of maintaining the fertility of the soil in phosphorus will be twenty times as difficult as for potassium; but this ratio by no means measures the real difference, for when a deposit contains a moderate percentage of a substance it may be possible to utilize it commercially; whereas, if the percentage falls below this amount. it is without value.

It is one of the great laws of nature that, under favorable conditions, the forces and agents of rock alteration tend to segregate locally each of the elements. To such processes of segregation are due the available metallic ores, since the average amounts of the valuable materials in the rocks are far below those in the workable ore deposits.

The segregative processes of nature have fortunately concentrated phosphorus in various ways, and these deposits are the chief source of supply of our phosphates.

The earliest phosphatic fertilizer to be used was guano, mainly derived from the islands off the west coast of South America. If the segregation of phosphorus in guano were fully described it would be appreciated how slow and intricate is the process of concentration of a rare element. The story would involve, first, the solution of the widely disseminated phosphorus from the original rocks, its segregation through complex processes in the small plants and animals that become the food of fishes, which in turn become the food of the sea birds. The dry excrement of the sea bird constitutes the guano. Much of the guano contains twenty-five to forty per cent.

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[1] Bulletin, U. S. Geol. Survey, No. 330.

phosphoric oxide. Thus nature's processes of segregation have multiplied the amount of phosphorus in the original rock by from one hundred to more than one hundred fifty fold.

Carcilas de la Vega,[2] in the sixteenth century, gave "a very interesting account of the manner in which the birds producing the guano were protected by the laws of the Incas, by which it was made a crime, punishable by death, to kill the sea fowl, gather their eggs, or even to visit the islands during the breeding season."

A recent report by Robert Coker[3] to the government of Peru upon the future of the guano industry and the guano-producing birds tells of "the robbery of eggs on a large scale in past years, the destruction of young and old birds, and the disturbance of the birds in their nesting grounds by the extraction of guano." He says an inevitable result "has been a great diminution in number." Mr. Coker's report pleads for regulations to increase the number of birds and thus to maintain perpetually a large supply of guano. With reference to the most precious of the fertilizers this twentieth century presents an ignominious and startling contrast with an ancient civilization.

In considering the ill treatment of the guano-producing birds it is difficult for one to retain composure and speak with moderation of the odious combination of human greed and brutality exhibited by this case of exploitation of a natural resource, in complete ignorance and absolute disregard of its effect upon the future of our race. The phrase "killing the goose that laid the golden egg" was never more applicable.

Long before man existed on the earth the ancient phosphatic segregations of birds and other animals formed upon an extensive scale were buried among the sediments and have been partially preserved in the rocks. These deposits constitute the chief sources of our mineral phosphates. Until recently the most extensive known deposits were those of Florida, South Carolina and Tennessee. In the year 1907 in these states almost exclusively, according to Mr. F. B. Van Horn, 2,265,343 tons of phosphate rock were produced. While the amount exploited is now large, none of the scientists who have examined these deposits hold out any hope that their extent is so great that they can be relied upon as a source of phosphate fertilizer for more than a very brief period. Van Horn estimates that the high-grade rock will be exhausted at the present rate of mining in about twenty-five years.

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[2] Johnson's Universal Ency., Vol. 4, p. 52.

[3] Science, July 10, 1908, p. 60.

Aside from these southern phosphates, we gain small amounts of phosphorus as by-products in the concentration of the magnetite iron ores of the east and from the slag of steel manufactured by the basic and open-hearth processes. These operations segregate the small amounts of phosphorus in the iron ores so as to give the by-products a marketable value. But from these sources we cannot expect more than an insignificant fraction of the phosphatic fertilizer required by the agricultural interests of the United States.

Fortunately, recent investigations[4] by the officers of the United States Geological Survey have shown that in Utah, Wyoming and Idaho are phosphatic deposits, regarded by Weeks and Ferrier, the reporting officers, as more extensive than have as yet been known to exist in this country.

At a number of places a rich phosphate bed five or six feet thick has been found, and above this bed are from fifty to one hundred feet containing thin layers of phosphate. While this western supply of phosphates is doubtless large, the explorations have been far too scanty to warrant any quantitative statement, and even under the most favorable hypothesis of continuity throughout the formation in which they exist, and of this they are sure to fall far short, they would still not be adequate to meet the needs of the nation through the centuries to come.

As yet the phosphate deposits of Utah, Wyoming and Idaho remain practically untouched. They are one of the most precious of the natural resources of the nation, having a value inestimably greater than might be supposed from the present marketable value of phosphate rock.

In Canada there are areas of crystalline rocks in which phosphates have been locally segregated. Also in other countries there are phosphatic deposits. But upon these foreign supplies we can in no way depend. The demand for phosphatic fertilizers by the agricultural interests of each country is sure to be so great that it may be confidently predicted that in the near future no nation will permit the exportation of phosphates, with the possible exception of countries like Peru, where large quantities are being produced each year through bird life.

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[4] Investigations relating to phosphates and phosphorus in 1907, F. B. Weeks and W. F. Ferrier. Bulletin No. 315, U. S. Geol. Survey.

Investigations relating to phosphates in 1907, F. B. Weeks, Bulletin No. 340, U. S. Geol. Survey.

The general and alarming decrease in the crop yield per acre in various states, so well described by Mr. James J. Hill, is largely due to the depletion of the soil in phosphorus. This is clearly shown by the investigations of the various agricultural stations. In order that the present relatively small productivity of the southern states may continue it requires the use each year of many thousands of tons of phosphate fertilizer. Even the soils of the rich central states, the garden of the United States, are deficient in this important element. The experiments of the Ohio station show that the use of phosphatic fertilizer largely increases the crop yield and is a source of great profit to those using it. Indeed, the work of this station upon different fertilizers showed that "for the soils tested in their experiments phosphorus was the controlling element in producing an increase in the cereal crop."[5]

Even for Illinois, correctly regarded as one of the most fertile states in the union, an extensive investigation by the state experiment station shows that "none of the soils are very rich in phosphorus, while many of them are considerably below the standard fertile soil, and two or three soils of large area are markedly deficient in that element, particularly the large areas of so-called white clay soil."[6]

These studies in Ohio and Illinois are confirmed by quantitative studies in Wisconsin. Whitson finds as a result of the average of nine typical tests that "the surface eight inches of virgin soil contains 2877 pounds of phosphoric oxide per acre, while that of the cropped fields contains but 1813 pounds, an average loss per acre on these cropped fields of 1064 pounds, or thirty-six per cent. of its original content. The average period of cropping for these fields has been 54.7 years." In other words, during the past half-century in Wisconsin one-third of the original phosphorus of the soil has been lost in the cropped fields. What has been proved for Ohio, Illinois and Wisconsin and other states where tests have been made is unquestionably true for the other states in the country which have been settled for some time.

[5] Ohio State Agricultural College. Bulletins Nos. 141, 182.

[6] Illinois Agricultural Experiment Station, Bulletin No. 68.

In what condition will the soil of the United States be as to phosphorus content fifty years hence if this process of depletion be allowed to continue unchecked?

The phosphorus which is taken out of the soil by cropping could be largely returned to it if all the manure of the domestic animals were saved and utilized. The experiments of the Ohio station show that the manure from domestic animals retains more than three-fourths of the phosphorus contained in the food and bedding, a large part of the remaining one-fourth being built up in the systems of the animals. Thus, if the excrement from all domestic animals, both in town and country, were returned to the soil more than three-fourths of the phosphorus would go back to it. But as yet our agricultural population is most delinquent as to the manner in which they handle the feces and urine of the domestic animals. Whitson estimates that the loss of phosphates in manure as a result of waste and wash amounts in Wisconsin to fifteen per cent., and this is probably less rather than more than the average for the country as a whole. The agricultural colleges and experiment stations, through teaching the students and through extension, have a heavy responsibility in driving home to the farmer the necessity of stopping the irreparable waste of the valuable fertilizers and especially the phosphates.

The phosphates which pass into the bones of domestic animals, so far as they are killed in the great abattoirs, become valuable by-products, which are sold to the farmer, and thus are returned to the soil.

There remains only to consider man as a source of phosphates, In this country there has been as yet practically no attempt to return the excrement of man to the soil. This is true of both country and city. In the country the solution of the problem of handling the human excrement so as to use it as a fertilizer is comparatively easy, but the education of the farmer so that he will apply the solution will prove a difficult task, which must be taken up at many thousands of centers. At the present time, through our concentrations into cities and towns, and the running of sewage into the streams, a large proportion of the human excrement, as well as that of animals, rich in phosphorus, goes to the rivers and thence to the sea, so that there is vast and unnecessary loss of the phosphates. Whitson estimates that the loss in the cities due to man alone is the equivalent of two or three pounds of phosphoric oxide per acre for the entire cropped region of the United States. Suppose this loss to be two pounds, this is 1/1000 of a ton, which amounts for the 400,000,000 acres to 400,000 tons of phosphoric oxide, or equivalent to 1,200,000 tons of phosphate rock. The method of sewage disposal now in vogue should be wholly abandoned and the phosphates of the sewage returned to the soil. The saved phosphates alone would more than justify the cost, without taking into account the enormous advantages of freeing the living water from pollution.

The wide disbursal of vast quantities of phosphorus which it took the process of nature an indefinite period to segregate, must cease. The loss is irreparable. In this matter we may well turn to China and Japan for guidance. The evidence is clear that the people of these ancient nations, which have had a dense population for many centuries and have preserved the fertility of their soils, have carefully saved and utilized animal and human excrement.

At the present time there is need for much more phosphate rock than we now quarry to neutralize the annual loss of the soil due to the waste of animal and human excrement. Whitson's investigations show the loss of phosphoric oxide in the fields tested in Wisconsin to be annually about twenty pounds per acre. To be conservative, let us suppose that the average loss for the United States is but one-half of this amount. For 400,000,000 acres, less than the total of the cropped land, this would represent an annual loss of 2,000,000 tons of phosphoric oxide; but since the phosphate mined is only about one-third phosphoric oxide, to supply this amount would require 6,000,000 tons of rock.

If we suppose the total accumulated loss of the soils of the United States from natural conditions due to cropping is one-half that found by Whitson in the fields tested in Wisconsin, the amount would be a quarter of a ton per acre, and for 400,000,000 acres, 100,000,000 tons of phosphoric oxide, which is the equivalent of 300,000,000 tons of phosphate rock. Thus, to make good the phosphorus already lost to the soil in the United States by reckless disregard of the future, would require the present output of our mines for more than a century, even if at once it were possible to prevent further depletion of the soil, and no more of our phosphate rock were required to neutralize the current waste.

In Sweden, the government decides as to whether it is wise to allow iron ore to be exported, and limits the amount which may be sent out of that country each year. In this country we have allowed to pass unnoticed the establishment of the Franco-American Consolidated Phosphate Company, the majority of the stock of which is owned abroad, and which has already acquired extensive holdings of phosphate lands in Tennessee. In 1907, even before the formation of this company, forty per cent. of the phosphate rock mined was exported, and doubtless the organization of this company will increase the proportion. This state of affairs could exist in no other civilized nation. Indeed, by the statesmen of foreign civilized nations exportation of phosphates would be regarded as unthinkable folly. If the statements presented in this paper are even approximately true, and it is believed that every one of them is justified, there should be a law which prohibits absolutely the exportation of a single pound of phosphate rock. It is not certain that the total supply of phosphate rock in the southern and western states together is sufficient to restore the lands of the United States to their original fertility in phosphorus, to say nothing of providing for the great annual loss through our present methods of handling fertilizers produced on the farms, and disposal of sewage.

During the summer of 1908 the attention of President Roosevelt was called to the facts presented in this paper, and it was urged that the western phosphate lands now owned by the Government should be withdrawn from private entry until such time as legislation could be secured to permit their exploitation upon a lease system, containing a clause preventing the exportation of the phosphates. Later the matter was again presented to the President and to James R. Garfield, then Secretary of the Interior. Both the President and Mr. Garfield instantly appreciated the fundamental importance of the matter, and on December 9, 1908, the phosphate lands of the west were formally withdrawn from private entry, thus retaining these deposits of fundamental importance to the future of the nation as its property.

It now remains for Congress to do its part in enacting appropriate legislation so that the fruits of the acts of the President and the Secretary may be permanently secured to the people. If no other result than this had come from the movement inaugurated by President Roosevelt to conserve the natural resources of the nation, all that has been done in this connection would have been justified many fold.

Hopkins[7] well says: "If he who makes two blades of grass grow where but one grew before is a public benefactor, then he who reduces the fertility of the soil so that but one ear of corn grows where two grew before is a public curse."

That nation only can reach the highest intellectual and spiritual level that is well nourished. Nourishment requires food. Food depends upon the necessary elements to feed the plants in the soil. Of these we can see no future danger so far as nitrogen and potassium are concerned, but because phosphorus is relatively so rare an element, because it has been segregated by the processes of nature in so limited an amount, since it is so essential to the growth of both plants and animals, it is clear that we should exercise the utmost foresight in conserving the natural concentrations of phosphorus and retaining that still in the soil.

Already we find our most basal resource, the soil, depleted by erosion, depleted by single cropping, and depleted most seriously of all by loss of phosphates. It is a fundamental duty of this generation to transmit to the succeeding generation the soil of the country undiminished in its productivity, for all other resources are as naught if the soil fails us. The damage that we have already done to this resource which should remain perpetually undiminished is inestimable and largely irreparable. The question now confronts us, shall we continue our present course of reckless impoverishment of the soil, taking no thought of the morrow?

We should work with the agents of the earth rather than reverse their work, as we have been doing since American settlement began.

How long shall this nation endure? Or more exactly, how long shall human beings occupy this land. As yet the human race is in its infancy. History goes back a few thousand years. The human race may have existed some score of thousands or even some hundreds of thousands of years; but while in years there is a considerable past history of the race, it is only within the past two centuries that the lands of the country have been subject to agriculture upon an extensive scale, and the main drafts upon the soil have been within the past century.

How long shall our people endure? We should think, not of a hundred years, nor of a thousand years, but of hundreds of thousands, or of millions of years of development of the human race. There is no reason, from a geological point of view, why human beings may not live upon this earth for millions of years to come, perhaps many millions of years, and so far as we are concerned, such periods as these are practically infinite.

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[7] Illinois Agricultural Experiment Station, Bulletin No. 68.

These considerations impose upon us as our most fundamental duty the transmission of the heritage of our natural resources to our descendants as little diminished as possible. This is an individual responsibility, as well as a state and national responsibility. There is a strongly developed opinion at the present time that the owners of great wealth and especially those who control great natural resources should act as trustees for the nation. This is easy to see; but a man who owns a farm is equally a trustee to the nation for this property. If, at the end of his life, the farm goes to his son depleted in richness, he is as truly faithless to his trust as are the great interests that think only of present gain and wastefully exploit the natural resources of the country. Each in proportion to his own responsibility is a traitor to the nation. At the present time, fortunately, this sense of stewardship is gaining possession of some of those who control the great resources of the nation. As yet there is scarcely a glimmering of responsibility in the case of the smaller holder of natural resources. But the future of the nation is only safe when small and large holder alike, from the man who owns forty acres of land to the small group of men who control the anthracite of the nation, shall administer their trust primarily for the benefit of succeeding generations rather than for themselves.

I do not hesitate to assert that from the point of view of our descendants, this question of conservation of our natural resources is more important than any political or social question, indeed, more important than all political or social questions, upon the solution of which we are now engaged. Not only is it more important, but it is pressing, for already our unnecessary losses in reference to the soil are irremediable, and the situation is growing steadily worse.

It is necessary that a great campaign of education be inaugurated at once with reference to the conservation of the soil, just as there has been a campaign of education with reference to the conservation of the forests. The task is an enormous one, indeed vastly greater than that carried on with reference to our other resources, because of the fact that the land holdings are so subdivided; but the campaign of education must be carried on, and as a part of it the laws must be developed until we reach the situation where no man dares so to handle his land as to decrease its fertility. If present methods are allowed to continue, it is certain that this country will be able to support only a sparse population. Only by the conservation of our soil undiminished in its fertility can we hope to be able to provide for the hundreds of millions of people who in the near future in the United States will be demanding food and clothing. The conservation of the soil is the conservation of the basal asset of the nation.

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